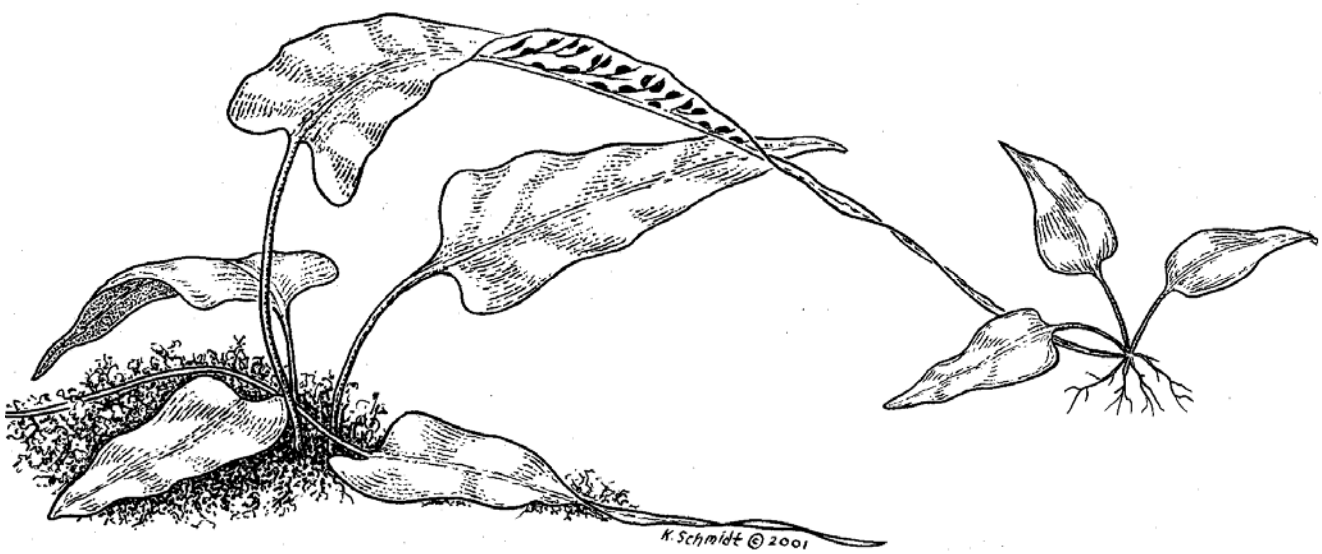
SIGNIFICANT HABITATS

IN THE

FISHKILL AND SPROUT CREEK CORRIDORS,

TOWNS OF BEEKMAN, LAGRANGE, AND FISHKILL,

DUTCHESS COUNTY, NEW YORK



Report to
the New York State Department of Environmental Conservation, the Town of Beekman, the Town of LaGrange, the Town of Fishkill, and the City of Beacon

NYSDEC Contract No. C302187

By
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Environmental Research and Education
Science for Conservation

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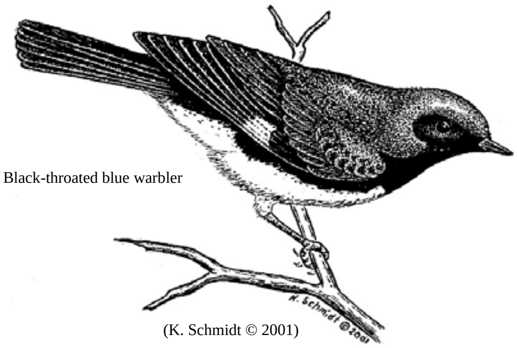


Black-throated blue warbler

(K. Schmidt © 2001)

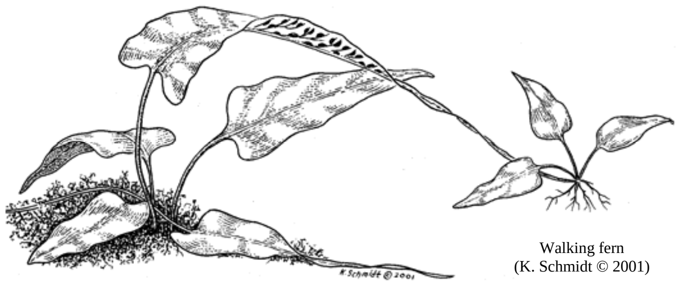
EXECUTIVE SUMMARY

Hudsonia Ltd. identified and mapped ecologically significant habitats in a 2,000 meter (6560 feet) wide corridor along Fishkill Creek and Sprout Creek in the towns of Beekman, LaGrange, and Fishkill between October 2003 and October 2005. The project was funded by the Hudson River Estuary Program of the New York State Department of Environmental Conservation as part of their Fishkill Creek watershed planning initiative.

Using map analysis, aerial photograph interpretation, and field observations, we created a series of large-format maps showing the location and configuration of ecologically significant habitats in the study area. These included widespread, common habitats, such as upland hardwood forest, upland meadow, and hardwood, as well as more unusual habitats such as fen, kettle shrub pool, and oak-heath barren. Some of these habitats are rare or declining in the region, while others are good quality examples of common habitats and habitat complexes. In total, we identified 33 different kinds of habitats in the corridor that we consider to be of potential ecological importance. In this report we describe some of the ecological attributes of each habitat, and discuss some conservation measures that can help to protect the habitats and the species of conservation concern they may support.

This is the third in a series of large habitat mapping projects conducted by Hudsonia in the Hudson Valley. The maps are intended to serve as tools for land use and conservation planning. This report and the accompanying habitat maps can help towns identify areas of greatest ecological significance, develop conservation goals, and establish conservation policies and practices that will help to protect biodiversity resources while serving the social, cultural, and economic needs of the human community.

INTRODUCTION



Walking fern
(K. Schmidt © 2001)

Background

Rural landscapes in the Hudson Valley are undergoing rapid change as farms and forests are converted to residential and commercial uses. The consequences of rapid land development include widespread habitat loss and degradation, habitat fragmentation, and the loss of native biodiversity. Although many land use decisions in the region are necessarily made on a site-by-site basis, the long-term viability of biological communities, habitats, and ecosystems requires consideration of whole landscapes. If general biodiversity information is available for large areas, such as whole towns, watersheds, or counties, then landowners, developers, and municipal planners will be better able to incorporate biodiversity protection into day-to-day decision-making.

To address this need, Hudsonia Ltd., a nonprofit scientific research and education institute based in Annandale, New York, initiated a series of large habitat mapping projects in Dutchess County in 2001. These projects demonstrate how Hudsonia's *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* (Kiviat and Stevens 2001) can be used to identify important biological resources and inform local communities about biodiversity conservation.

Hudsonia has completed town-wide habitat maps for the towns of East Fishkill (Stevens and Broadbent 2002) and Washington (Tollefson and Stevens 2004), and will complete the habitat map for Stanford (Bell et al. in prep.) in December 2005. We are also nearing completion of a map of potential habitats of the Blanding's turtle, a New York State Threatened species, in six towns in southern Dutchess County (Hartwig et al. in prep.).

The Hudson River Estuary Program of the New York State Department of Environmental Conservation, recognizing the inseparability of watersheds and stream quality, has been supporting watershed planning initiatives for Hudson River tributaries. The Estuary Program provided the funding for the present mapping project so that biodiversity could be considered along with other planning concerns in the Fishkill Creek and Sprout Creek corridors. This report discusses the scope and findings of that project, and is accompanied by three large-format (wall-sized) habitat maps, one for each of the three towns in the study area.

John Sullivan (Biologist) and Gretchen Stevens (Director, Biodiversity Resources Center) conducted the work on this project from October 2003 through October 2005. Using map analysis, aerial photograph interpretation, and field observations, we created maps of ecologically significant habitats in a 6560-foot (2000-meter) wide corridor centered along Fishkill Creek in the towns of Beekman and Fishkill, and along Sprout Creek in the town of LaGrange. Some of these habitats are rare or declining in the region, while others are high quality examples of common habitats. The emphasis of this project was on identifying and mapping general habitat types, and not on conducting species-level inventories or mapping the known locations of rare species.

This is the third in a series of large habitat mapping projects conducted by Hudsonia. We will soon be completing similar projects in several more towns in Dutchess County, and hope to extend the program to other parts of the county and region. To facilitate intermunicipal planning, we strive for consistency between towns in the ways that we define and identify habitats and present the information for town use, but we also expect to improve our methods and products as the program evolves. Many passages in this report relating to general conservation concepts and other information applicable to the region as a whole are taken directly from the East Fishkill (Stevens and Broadbent 2002) and the Town of Washington (Tollefson and Stevens 2004) reports without specific attribution. We have adapted the report, however, to encompass our findings and recommendations for the Fishkill Creek and Sprout Creek corridors. We intend that each of these projects will build on the previous ones, and believe that the expanding body of biodiversity information will be a valuable resource for site-specific, town-wide, and region-wide conservation efforts.

What is Biodiversity?

The concept of biological diversity, or biodiversity, encompasses all of life and its processes. It includes ecosystems, biological communities, species, and their genes, as well as their interactions with each other and with the non-biological components of their environment, such as soil, water, air, and sunlight. Many ecologists agree that protecting native biodiversity is essential to maintaining healthy, functioning ecosystems that sustain the human community and the living world around us. Healthy ecosystems make the earth habitable by moderating the climate, producing oxygen, purifying water and air, producing and decomposing organic matter, and providing many other essential services. They also help to produce and sustain extractable and harvestable resources on which human economies are based.

The decline or disappearance of native species can warn us of environmental deterioration, and may be part of collapses in other parts of the ecosystem. While we do not fully understand the role of most organisms in the ecosystem and cannot fully predict the consequences of the extinction of any particular species, we do know that even some inconspicuous organisms, such as fungi or insect pollinators, can play critical roles in the maintenance of certain biological communities. Maintaining the full complement of native species in a region can allow an ecosystem to respond to stresses and adapt to changing environmental conditions.

What are Ecologically Significant Habitats?

For purposes of this project, a “habitat” is simply the place where an organism or population lives or where a biological community occurs, and is defined according to its biological and non-biological components. Individual species will be protected for the long term only if their habitats are maintained intact. The local or regional disappearance of a habitat can lead to the local or regional extinction of species that depend on the habitat. For these reasons, and because habitats are a manageable unit for planning and conservation, the focus of this project is on identifying and mapping ecologically significant habitats. Habitats that we consider to be “ecologically significant” include:

1. Habitats that are rare or declining in the region.
2. Habitats that support rare species and other species of conservation concern.

3. High-quality examples of common habitats (e.g. those that are especially large, isolated from human activities, old, lacking harmful alien species, or those that provide connections between other important habitat units).
4. Complexes of connected habitats that, by virtue of their size, composition, or configuration, have significant biodiversity value.

Because most wildlife species need to travel among different habitats to satisfy their basic needs, landscape patterns can have a profound influence on wildlife populations. The size, connectivity, and juxtaposition of both common and uncommon habitats in the landscape all have important implications for biodiversity. By illustrating the location and configuration of ecologically significant habitats throughout the Fishkill and Sprout Creek corridor, the habitat maps produced for this project can serve as a valuable source of ecological information that can be incorporated into local land use planning and decision making.

Study Areas

We mapped ecologically significant habitats in a 6560 ft (2000 m) wide corridor centered along Fishkill Creek in the towns of Beekman and Fishkill, and along Sprout Creek in the Town of LaGrange. The variability in geology, topography, and land use history of these three towns resulted in marked differences in the type and quality of habitats found in each. A brief description of the study area in each town is given below.

TOWN OF BEEKMAN:

The Town of Beekman has a residential and agricultural character with some large tracts of undeveloped land. Most development and agricultural land use occurs in the lowlands, which generally parallel Fishkill Creek through the center of the town. The town encompasses an area of approximately 30 square miles (78 square kilometers). As of the 2000 Census, Beekman had a population of 13,655 (including a correctional institution with a population of 2,303), a population density of 455 people per square mile (175 people per square kilometer), and approximately 115 mi (185 km) of roads.

Most of the town is drained by Fishkill Creek, a major tributary of the Hudson River. Elevations range from 310 ft (95 m) in the farmland south of Sylvan Lake to 1336 ft (407 m) at the southern tip of the town, south of Pepper Hill Rd. The eastern and southern parts of town are characterized by high hills; about half of the acreage is in large parcels of land owned by New York State, the National Park Service, and private landowners. The northwestern section of town is characterized by lowlands and smaller hills (elevations up to 860 ft [262 m]). The bedrock geology of Beekman is primarily granitic gneiss in the southeastern highlands and limestone, dolostone, and shale in the Fishkill Creek valley (Fisher et al. 1970). Phyllite, schist, and meta-graywacke dominate the hills in the northern part of town. A narrow band of quartzite conglomerate and gneiss with amphibolite and calcsilicate rock separates the granitic gneiss from the calcareous bedrock of the valley. Surficial geology is primarily glacial till along the Fishkill Creek valley with several small kame deposits throughout (Cadwell 1989). Outcrops of bedrock are common in the higher elevations on either side of the valley.

The study area in Beekman encompassed about 3,900 acres (1578 hectares) or 20 percent of the town. Soils in this corridor are strongly influenced by the underlying limestone bedrock (Figure 1). Several large wetland complexes occur along the floodplain of Fishkill Creek in the southern portion of the corridor.

TOWN OF LAGRANGE:

The Town of LaGrange is characterized by residential and commercial development mixed with agricultural land uses. LaGrange encompasses approximately 40 mi^2 (104 km^2) and, as the 2000 Census had a population of 14,928 people, a population density of 373 people per square mile (144 people per square kilometer), and contains 174 mi (280 km) of roads. A little over half of the town drains into Sprout Creek, a major tributary of the Fishkill Creek. The eastern half of the town drains into Wappinger Creek, another major tributary of the Hudson River. LaGrange's topography is much less rugged than Beekman and Fishkill's; elevations range from 110 ft (34 m) along the Wappinger Creek to 810 ft (247 m) in the northeastern hills.

The bedrock geology of LaGrange is varied. Along the Sprout Creek and Fly Sprout corridors, much of the bedrock is composed of shale, argillite, and siltstone (Fisher et al. 1970). East of Sprout Creek is mostly schist, with minor meta-graywacke lenses. Other bedrock in the town includes amphibolite, limestone, conglomerate, and quartzite. Surficial geology is composed of glacial till with glacial outwash deposits along Jackson Creek, Sprout Creek, Fly Sprout, and Wappinger Creek and its tributaries (Cadwell 1989). Shale outcrops occur throughout much of the town, especially in the northern hills.

The study area in LaGrange encompassed nearly 6,262 ac (2,534 ha) or 24 percent of the town. Soils in the more elevated portions of the corridor are strongly influenced by the underlying shale bedrock (Figure 1), while broad areas along the lower Sprout Creek valley contain extensive glacial outwash soils (Faber 2002). A number of large wetland complexes occur along the floodplain of Sprout Creek and in the adjacent glacial outwash plain.

TOWN OF FISHKILL:

The Town of Fishkill is highly suburbanized with at least one major population center, the Village of Fishkill. The southern part of the town has steep, rugged hills, and the northern part has less rugged terrain with extensive wetlands. The southern ridges of Fishkill are mostly undeveloped; large tracts of land are owned by New York State, Scenic Hudson Land Trust, Inc., and the Fresh Air Fund. Fishkill, including the Village of Fishkill, encompasses approximately 32 mi^2 (83 km^2). As of the 2000 Census, these two municipalities had a total population of about 19,256 people and a population density of 602 people per square mile (232 people per square kilometer). The town has approximately 130 mi (209 km) of roads. Most of Fishkill is drained by the Fishkill Creek. Areas along the western border drain directly into the Hudson River. Elevations in Fishkill range from 0 ft (0 m) on the Hudson River shore to 1610 ft (491 m) at South Beacon Mountain.

The bedrock varies considerably, with granite and gneiss common in the southern hills and a mixture of graywacke, shale, argillite, chert, and some limestone and dolostone in the low-lying terrain to the north (Fisher et al. 1970). The surficial material is mostly glacial till, but some glacial lake deposits occur in the southwest (Cadwell 1989). Glacial outwash deposits are scattered along the Fishkill Creek valley and the valleys of its tributaries, including Clove Creek and Bloomer Brook (Faber 2002). Extensive areas of exposed granite and gneiss occur in the southern hills.

The study area in Fishkill encompassed nearly 5,802 ac (2,348 ha) or 28 percent of the town. Soils along the steep ridges are notably shallow and strongly influenced by the acidic granite and gneiss bedrock (Figure 1). The low-lying terrain contains a mix of soils derived from glacial till and soils that have been significantly altered by urban land use. A few moderate sized wetland complexes occur along the corridor, particularly at the mouth of Fishkill Creek and on several undeveloped floodplain terraces.

CITY OF BEACON:

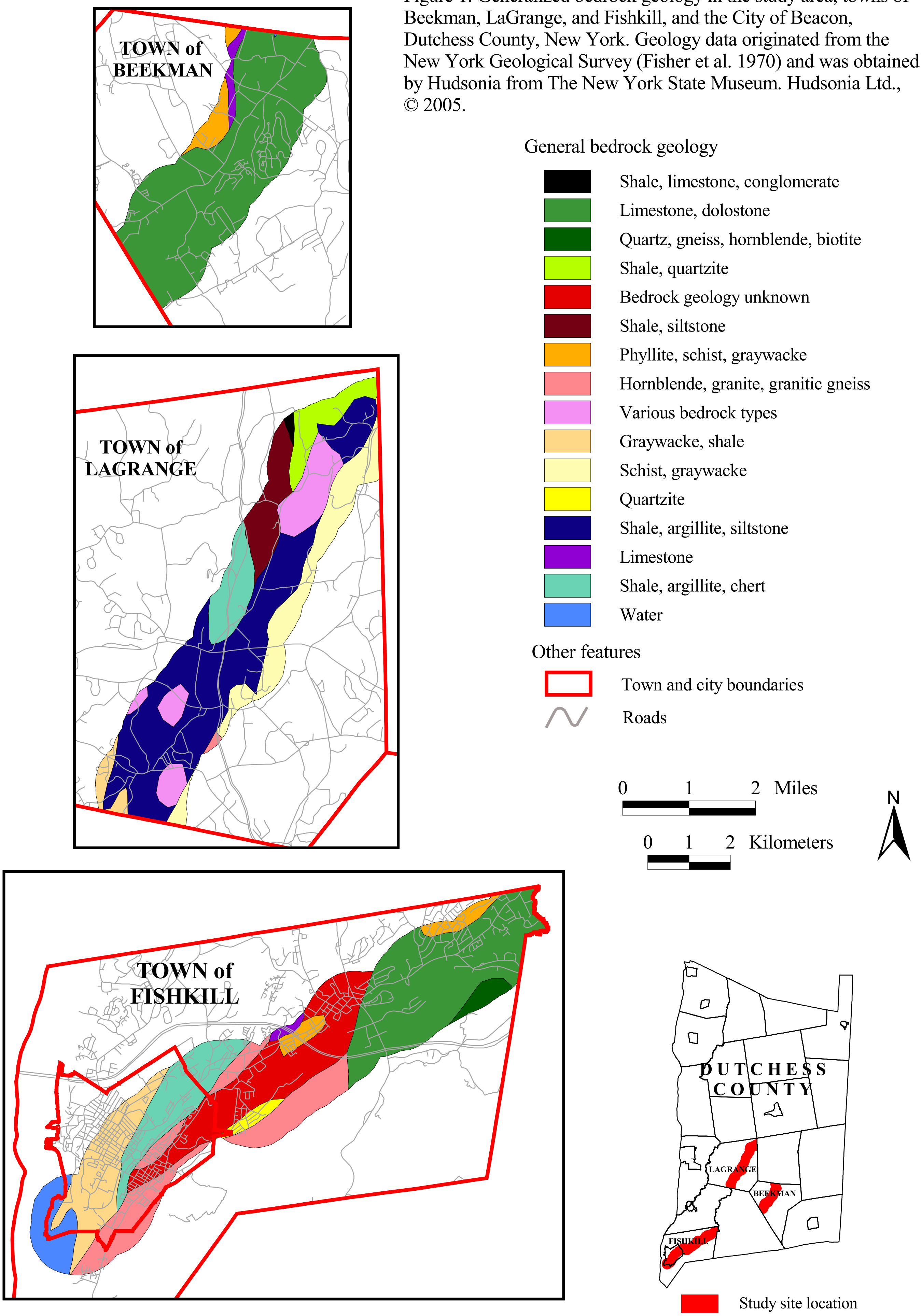
The City of Beacon is intensively developed, but contains some undeveloped land along its perimeter. The Fishkill Correctional facility owns a large area of undeveloped land in the northeast corner, including some working farmland. The City of Beacon encompasses nearly 5 mi^2 (13 km^2), and had a population of 14,810 people and a population density of 2,962 people per square mile (1139 people per square kilometer) as of the 2000 Census. The city has approximately 62 mi (100 km) of roads.

The City of Beacon drains into the Hudson River directly and via the Fishkill Creek. The southeast section of city is in the foothills of the Hudson Highlands and the topography is quite steep. The rest of the city is characterized by small hills and lowlands. Bedrock geology is highly variable, and includes graywacke, shale, argillite, chert, and granitic gneiss (Fisher et al. 1970). Surficial materials are mostly glacial till, but there are outwash and lacustrine deposits near the mouth of the Fishkill Creek and in the northern part of the city (Cadwell 1989).

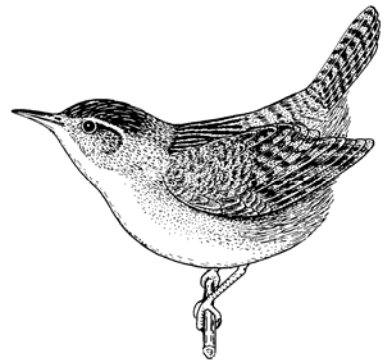
The study area in the City of Beacon encompassed nearly 2,285 ac (925 ha) or 73 percent of the city. Most soils in the low-lying portion of the corridor have been significantly altered from urban land use. An intertidal wetland complex occurred at the mouth of the Fishkill Creek.

For simplicity, the Town of Fishkill, Village of Fishkill, and the City of Beacon are hereafter referred to as the "Fishkill" portion of the study area, and the total area of the Fishkill corridor (i.e. 8,087 ac [3,272 ha]) is used in all calculations.

Figure 1. Generalized bedrock geology in the study area, towns of Beekman, LaGrange, and Fishkill, and the City of Beacon, Dutchess County, New York. Geology data originated from the New York Geological Survey (Fisher et al. 1970) and was obtained by Hudsonia from The New York State Museum. Hudsonia Ltd., © 2005.



METHODS



Sedge wren
(K. Schmidt © 2001)

Hudsonia employs a combination of map analysis, aerial photo interpretation, and field observation in the habitat identification and mapping process. Below, we describe each phase in the Fishkill Creek and Sprout Creek corridor habitat mapping project.

Study Area Identification

We identified and mapped significant habitats in a corridor extending 3280 ft (1000 m) in both directions from the center of Fishkill Creek in the towns of Beekman and Fishkill, and from the center of Sprout Creek (a major tributary of Fishkill Creek) in the town of LaGrange. Thus the total width of the corridor was 6560 ft (2000 m) in each town. We delineated the corridor on-screen using ArcView 3.2 Geographic Information System (GIS) software and digital orthophotos (described below). Generally, only habitats lying within this corridor were identified, mapped, and field checked. At two locations the corridor boundaries were expanded slightly to include highly significant habitats (e.g. intermittent woodland pool and fen) that were just beyond the 3280 ft (1000 m) limit.

Gathering Information and Predicting Habitats

Over many years of habitat studies in the Hudson Valley, Hudsonia has found that, with careful analysis of map data and aerial photographs, we can accurately predict the occurrence of many habitats. First we assemble all relevant maps, GIS data, and existing published and unpublished information from biologists who have worked in the area. We then use combinations of map features (e.g. bedrock chemistry, soil depth and drainage, slopes) and features visible on aerial photographs (e.g. exposed bedrock, vegetation cover types) to predict the location and extent of ecologically significant habitats. In addition to previous studies conducted by Hudsonia biologists and biological data provided by the New York Natural Heritage Program, we also used the following resources for this project:

- *1:40,000 scale color infrared aerial photograph prints from the National Aerial Photography Program series taken in the spring of 1994 and 1995, obtained from the U.S. Geological Survey.* Viewed in pairs, stereoscopic aerial photograph prints provide a three-dimensional view of the landscape and are extremely useful for identifying vegetation cover types, wetlands, streams, and cultural landscape features. For interpretation of aerial photograph prints, we used a Geoscope mirror stereoscope with 3x eyepiece (obtained from Forestry Suppliers, Inc.).

- *High resolution (1 pixel = 7.5 in [19 cm]) true color digital orthophotos (NY State Plane, NAD 83, units of feet) taken in spring 2000 and obtained from the Dutchess County Office of Real Property Tax*. We used digital orthophotos as a base layer in GIS for the onscreen mapping of habitats.

- *U.S. Geological Survey topographic maps (Hopewell Junction, Pleasant Valley, Poughquag, Verbank, Wappingers Falls, and West Point 7.5 minute quadrangles).* Topographic maps contain extensive information about landscape features such as elevation, landscape contours, surface water features and some wetlands, significant cultural features, and general land cover. Contour lines on topographic maps can be used to predict the occurrence of such habitats as cliffs, intermittent woodland pools, intermittent streams, and seeps.

- *Bedrock and surficial geology maps (Lower Hudson Sheets) produced by the New York Geological Survey (Fisher et al. 1970, Cadwell 1989).* Surficial and bedrock geology strongly influence the development of particular soil properties and aspects of groundwater and surface water chemistry, and thus have important implications for the plant and animal communities that become established on any site.

- *Soil Survey of Dutchess County, New York* (*Faber* 2002*).* Specific attributes of soils, such as depth, drainage, texture, and pH, can tell us a great deal about the types of habitats that are likely to occur in an area. Shallow soils in steep terrain, for example, may indicate the location of crest, ledge, and talus habitats. Poorly and very poorly drained soils usually indicate wetland habitats, such as swamps, marshes, and wet meadows. The location of alkaline soils can be used to predict the occurrence of calcareous ledges, fens, and calcareous wet meadows.

- *GIS data*. GIS enables us to overlay multiple map layers on the computer screen, greatly enhancing the efficiency and accuracy with which we can predict a variety of habitats that are closely linked to local topography, geology, hydrology, and soil conditions. We obtained most of our GIS data layers from the Dutchess County Environmental Management Council (EMC), including roads, streams, soils, bedrock geology, surficial geology, state regulated wetlands, and National Wetland Inventory data prepared by the U.S. Fish and Wildlife Service. We also obtained 10-ft (3-m) contour data for the towns of Beekman, LaGrange, and Fishkill from the Dutchess Land Conservancy, and tax parcel data for the three towns from the Dutchess County Office of Real Property Tax. Additional GIS data layers were obtained from the New York State GIS Clearinghouse website (www.nysgis.state.ny.us) including medium resolution (3.25 ft [1 m] horizontal accuracy) infrared digital orthophotos taken in spring 1994 and USGS digital topographic quadrangles (DRGs) for each town. We re-projected GIS layers into New York State Plane NAD 1983, units of feet.

Preliminary Habitat Mapping and Field Verification

We prepared a preliminary map of predicted habitats based on map analysis and stereo interpretation of aerial photographs. We digitized the predicted habitats onscreen over the spring 2000 digital orthophoto images using ArcView 3.2 mapping software on a Dell Latitude D600 computer.

Before going into the field, we contacted individual property owners for permission to enter their land. We prioritized sites for field visits based both on opportunity (e.g. willing landowners) and on our need to answer questions regarding habitat identification or extent that could not be answered remotely. There are several habitat distinctions, for example, that can only be made in the field such as wet meadow vs. calcareous wet meadow, wet meadow vs. fen, and calcareous crest vs. acidic crest. We brought our draft habitat maps with us into the field, where we visited as many of the mapped habitat units as possible to verify their presence and extent. In addition to conducting field work on public and private land, we also viewed habitats visible from public roads and other public access areas.

We estimate that we field checked part or all of 75 percent of the mapped habitat units. Inaccessible areas that could not be field-checked were mapped entirely by remote sensing. We assume that the mapped areas that were field checked are generally more accurate than those we did not visit in the field. Once we have conducted field work in one area, however, we are able to extrapolate our findings to adjacent parcels and similar settings. Because the timeline of this project prevented us from conducting intensive field verification on every parcel in the study area, this strategy increased our efficiency while maintaining a high standard of accuracy.

Refining the Habitat Map

We corrected and refined the preliminary map on the basis of our field observations to produce the final habitat map. We established certain mapping conventions to simplify our work and to improve the consistency of the final habitat map:

- *Developed areas*. Developed areas (including structures, roads, and other impervious surfaces, as well as immediately surrounding areas) were excluded from the habitat map. Areas that have been developed since 2000 (the orthophoto date) were identified as such only if we observed them in the field. For this reason, it is likely that we underestimated the areas of developed land in the study area. Typically, we mapped habitats surrounded by or intruding into developed land only if their dimensions exceeded 165 ft (50 m) in all directions, or if they seemed to provide important connections to other large habitat areas. We did, however, map wetlands within developed areas if they were identifiable on the aerial photographs. These wetland habitats can serve as important drought refuges for rare species and other species of conservation concern.

- *"Cultural" areas.* Intensively managed areas such as golf courses, cemeteries, and large manicured lawns were mapped as "cultural" habitats. We mapped these areas not for their current habitat value, which is often negligible, but for their potential value should they cease to be managed.

- *Upland hardwood forests.* Although these forests are extremely variable in terms of their species composition, size and age of trees, vegetation structure, soil drainage and texture, and other factors, we decided to map upland hardwood forests as a single habitat type for practical reasons. Different forest ages and types are not easily distinguished on aerial photographs, and using remote sensing we could not consistently and accurately separate forests according to dominant tree species or size of overstory trees. Our "upland hardwood forest" type therefore includes non-wetland deciduous forests of all ages, at all elevations, and of all species mixtures. Coniferous-deciduous mixed forests and conifer forests were mapped separately.

- *Upland meadow and upland shrubland.* Pastures, agricultural fields, equestrian fields, and abandoned fields were all mapped as "upland meadow." We mapped upland meadows divided by fences, hedgerows, and unpaved roads as separate polygons, to the extent that these features were visible on the aerial photographs. Because upland meadows often have a substantial shrub component, the distinction between upland meadows and upland shrubland habitats is somewhat arbitrary. In general, we defined upland shrubland habitats as those with widely distributed shrubs that accounted for greater than 20% cover.

- *Crest, ledge, and talus habitats.* Because crest, ledge, and talus habitats are usually embedded within other habitat types (most commonly upland forest), they are depicted as an overlay on the base habitat map. Except for the most exposed ledges, these habitats do not have distinct signatures on aerial photographs and are therefore mapped based on a combination of field observations and locations of potential bedrock exposures inferred from the location of shallow soils (<20 inches [50 cm]) on steep (>15%) slopes. The final overlay of crest, ledge, and talus habitat is therefore an approximation, and we expect that there are additional bedrock exposures outside the mapped areas. The precise locations and boundaries of crest, ledge, and talus habitats should be determined in the field on a site-by-site basis. The distinction between calcareous and non-calcareous crest, ledge, and talus habitats can only be made in the field. The areas mapped as calcareous crest, ledge and talus, therefore, are extrapolated from the locations of calcareous outcrops observed in the field. Most other areas of exposed bedrock (both non-calcareous and unknown bedrock) were mapped as crest, ledge, and talus. The "oak-heath barren" is an uncommon type of crest and ledge habitat with a distinctive plant community. We mapped this separately because of its special biodiversity potential.

- *Wetlands.* We predicted and mapped wetlands remotely using topographic maps, soils data, and aerial photographs. In the field, we identified wetlands primarily by the predominance of hydrophytic (wetland) vegetation and easily visible indicators of surface hydrology (Environmental Laboratory 1987). We did not ordinarily examine soil profiles for the presence of hydric (wetland) soil indicators. Along some stream corridors and in other low-lying areas with somewhat poorly-drained soils it was often difficult to distinguish between upland forest and hardwood swamp without the benefit of onsite soil data. In the field, these areas were characterized by moist, fine-textured soils with common upland trees in the canopy and, often, dense thickets of vines and shrubs (e.g. Japanese barberry, Eurasian honeysuckle) in the understory. In most cases, we mapped these areas as upland forest. The locations of wetland boundaries (and all other habitat boundaries) on the habitat map should be treated as approximations, and should not be used for jurisdictional determinations. Wherever the actual locations of wetland boundaries are needed to determine jurisdictional limits, the boundaries must be identified in the field by a wetland scientist and mapped by a land surveyor.

- *Intermittent woodland pools.* Intermittent woodland pools are best identified in the spring, when the pools are generally full of water and occupied by invertebrates and breeding amphibians. The presence of fairy shrimp is often a good indicator that the standing water is intermittent. Intermittent woodland pools visited in late summer and fall were identified based on physical features of the habitat (e.g. shallow basin with dark-stained leaves). The pools we did not visit in the field were mapped using remote sensing techniques. Many intermittent woodland pools have a distinct aerial photograph signature, and are readily visible within areas of deciduous forest on photographs taken during leaf-off seasons. Intermittent woodland pools located within areas of conifer forest, however, are not easily identified on aerial photographs, and it is likely that we missed some during our mapping. A small number of intermittent pools located within drier wetland habitats (but still isolated from water bodies and streams with fish) were mapped as intermittent woodland pools. All intermittent woodland pools should be verified in the field on a site-by-site basis.

- *Springs & seeps.* Springs and seeps are difficult to identify by remote sensing, so we mapped only the few we happened to see in the field. We expect there are many more springs and seeps along the Fishkill Creek corridor that we did not map. The precise locations and boundaries of seeps and springs should be determined in the field on a site-by-site basis. In one instance, we mapped a broad area with numerous individual seeps using a special seep polygon overlay on the base habitat map.

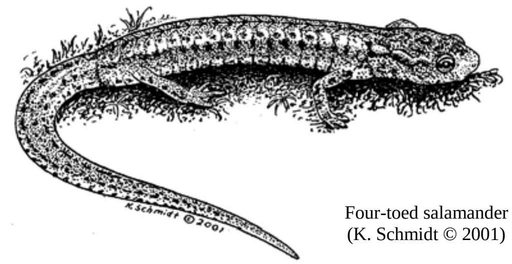
- *Streams.* A digital stream layer was created by the Dutchess County EMC based on the New York State Department of Environmental Conservation (NYSDEC) 1:24,000 Biological Survey Series Maps created in 1991. Because these data were incomplete for the study area, however, we digitized a new stream coverage in ArcView GIS based on these original data, field observations, and interpretation of topographic maps and aerial photographs. We added numerous perennial and intermittent streams to the coverage and connected the sections of stream that had been depicted as discontinuous where they flowed through ponds, impoundments, or large wetlands. We expect there are additional intermittent streams that we missed, and we recommend these be added to the database as information becomes available. Because it was often difficult to distinguish between perennial and intermittent streams based on aerial photograph and map interpretation, these distinctions were made using our best judgment.

The final large-format paper maps of the study areas in each of the three towns were printed at a scale of 1:10,000 on a Hewlett Packard DesignJet 800PS plotter. The GIS database that accompanies the map includes additional information about many of the mapped habitats, such as the dates of field visits and plant and animal species observed in the field. The habitat map, the GIS database, and this report have been conveyed to the New York State Department of Environmental Conservation, the Town of Beekman, the Town of LaGrange, the Town of Fishkill, the City of Beacon, and the Dutchess County EMC for use in conservation and land use planning and decision making. We request that any maps printed from this database for public viewing be printed at scales no larger than 1:10,000, and that the habitat map data be attributed to Hudsonia Ltd. Although the habitat map was carefully prepared and extensively field-checked, there are inevitable inaccuracies in the final map. Because of this, we request that the following caveat be printed prominently on all maps:

> *"This map is suitable for general land use planning, but is unsuitable for detailed planning and site design or for jurisdictional determinations. Boundaries of wetlands and other habitats depicted here are approximate."*

RESULTS

Overview



Four-toed salamander
(K. Schmidt © 2001)

The large-format habitat maps for the study area illustrate the diversity of habitats in this corridor and the complexity of their configuration on the landscape. Reductions of those maps are shown in Figures 2, 3, and 4. In total, we identified 33 different kinds of habitats (Table 1) that we consider to be of potential ecological importance in the study area. Some of the more unusual or rare habitats we documented include acidic bog, fen, kettle shrub pool, intertidal marsh, oak-heath barren, clay bluff, and clay ravine. These habitats have special potential to support certain rare species and are therefore considered to be particularly important for maintaining overall biodiversity within the Fishkill Creek and Sprout Creek corridors.

Table 1. Ecologically significant habitats identified in the Fishkill and Sprout creek corridors, towns of Beekman, LaGrange, and Fishkill, and City of Beacon, Dutchess County, New York, 2003-2005.

Upland Habitats	Nontidal Wetland & Stream Habitats	Tidal & Supratidal Habitats
upland hardwood forest	hardwood and shrub swamp	estuarine rocky shore
upland conifer forest	conifer swamp	supratidal railroad causeway
upland mixed forest	marsh	intertidal marsh
red cedar woodland	wet meadow	intertidal mudflat
upland shrubland	calcareous wet meadow	intertidal swamp
upland meadow	wet clay meadow	tidal tributary mouth
oak-heath barren	fen	
crest/ledge/talus	acidic bog	
calcareous crest/ledge/talus	intermittent woodland pool	
clay bluff & ravine	kettle shrub pool	
orchard/plantation	open water	
cultural	constructed pond	
waste ground	spring/seep	
	intermittent & perennial stream	

The study area varied considerably in character and extent of land uses in the three towns. For example, only 55% of the Fishkill portion of the study area was undeveloped (i.e. without structures, paved roads, etc.), while nearly 70% of the Town of Beekman portion of the corridor and 82% of the Town of LaGrange portion of the corridor were undeveloped. Table 2 provides a comparison of the total corridor area within each town that was either forested, upland meadow and upland shrubland, or wetland and other aquatic habitats.

Table 2. Percent and total area (acres) of the study area occupied by three general habitat types.

Habitat Type	Town of Beekman	Town of Fishkill[1]	Town of LaGrange
Upland Forested	27% (1056 ac)	28% (2227 ac)	46% (2900 ac)
Upland Meadow & Shrubland	24% (951 ac)	5% (426 ac)	16% (985ac)
Wetland & Other Aquatic	14% (530 ac)	15% (1,236 ac)	15% (940 ac)

[1] Includes the Village of Fishkill and the City of Beacon portions of the study area.

All mapped habitat areas, while still considered to be ecologically significant, have been altered to varying degrees by past and present human activities. Most areas of upland forest, for example, have been logged more than once in the past 250 years, and many forested areas lack the structural complexity of old forests. Many of the wetlands have been extensively altered by human activities (e.g. dredging, damming, removal of buffers, nutrient loading). Although we have documented the location and extent of important habitats within the study area, we have not assessed the quality and condition of most habitat units.

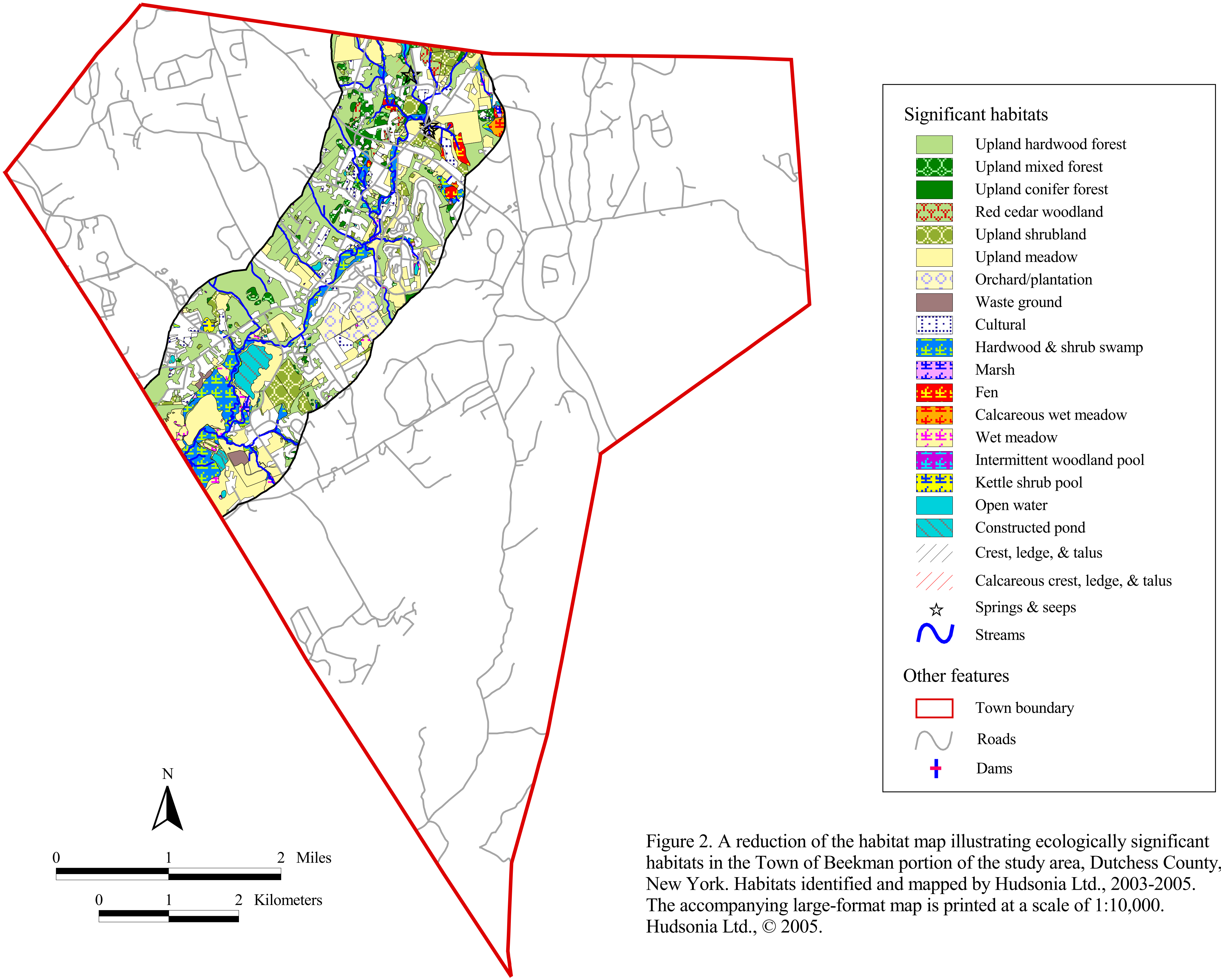


Figure 2. A reduction of the habitat map illustrating ecologically significant habitats in the Town of Beekman portion of the study area, Dutchess County, New York. Habitats identified and mapped by Hudsonia Ltd., 2003-2005. The accompanying large-format map is printed at a scale of 1:10,000. Hudsonia Ltd., © 2005.

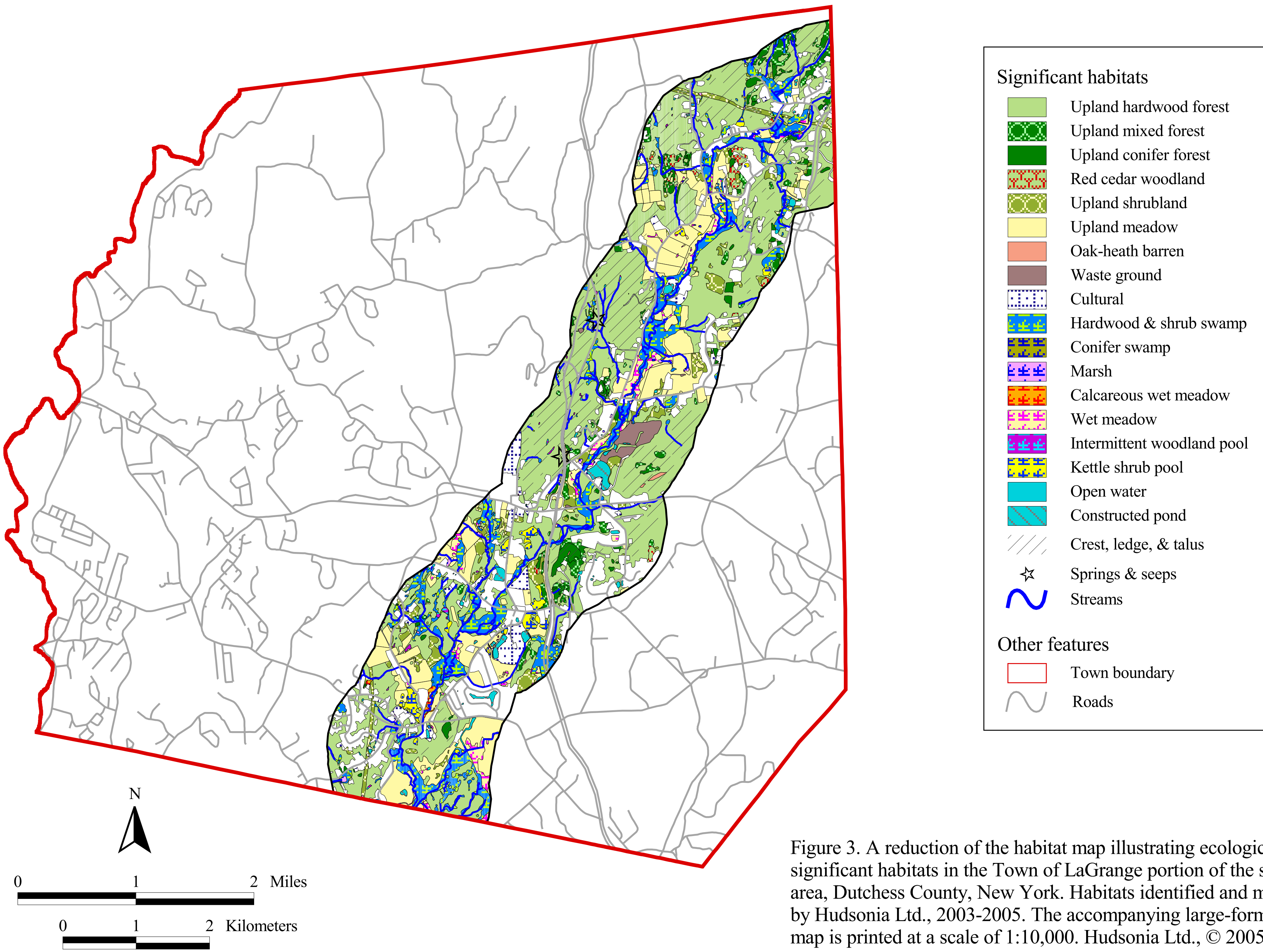


Figure 3. A reduction of the habitat map illustrating ecologically significant habitats in the Town of LaGrange portion of the study area, Dutchess County, New York. Habitats identified and mapped by Hudsonia Ltd., 2003-2005. The accompanying large-format map is printed at a scale of 1:10,000. Hudsonia Ltd., © 2005.

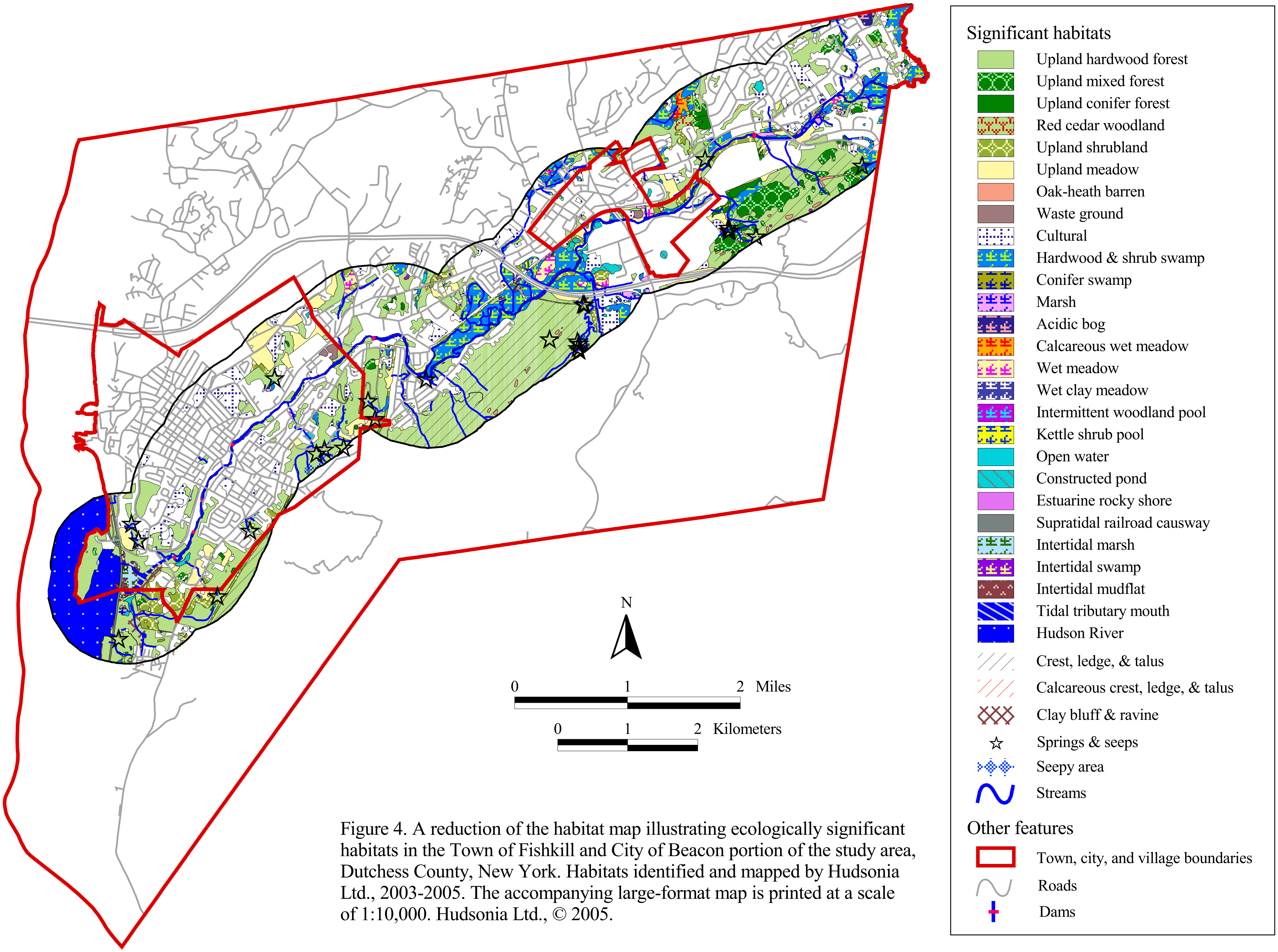


Figure 4. A reduction of the habitat map illustrating ecologically significant habitats in the Town of Fishkill and City of Beacon portion of the study area, Dutchess County, New York. Habitats identified and mapped by Hudsonia Ltd., 2003-2005. The accompanying large-format map is printed at a scale of 1:10,000. Hudsonia Ltd., © 2005.

HABITAT DESCRIPTIONS

Introduction

In the following pages we broadly describe the habitats identified in the study area, and discuss some conservation measures that can help to protect those habitats and the species of conservation concern they may support. All of the species we mention in the habitat descriptions occur in the Hudson Valley and have the potential to occur in the study area. We assigned a code to each habitat type (e.g. upland conifer forest = ucf; marsh = ma) that corresponds to the codes appearing on the large-format habitat maps. Species of particular conservation concern mentioned in the text are indicated by an asterisk (*) following the species name. Appendix A provides a more extensive list of rare species associated with each habitat, including their statewide and regional conservation status. The rarity ranks given in Appendix A are explained in Appendix B. Appendix C gives the common and scientific names of all plants mentioned in this report. Many of the wetlands discussed in this report also appear on the New York State Freshwater Wetlands maps. For these wetlands, the New York State wetland names (e.g. “NYS wetland PV-53”) are given in parentheses in the text.

UPLAND HABITATS

UPLAND FORESTS

Ecological Attributes

We identified three general types of upland forest habitat in the study area: upland hardwood forest, upland conifer forest, and upland mixed forest.

Upland Hardwood Forest (uhf)

Many hardwood forests in the study area, particularly those at lower elevations, appeared to be highly disturbed by current and past human activity. These forests were dominated by early successional or non-native tree species such as black locust, black cherry, and eastern cottonwood. White ash and sugar maple were also common. The shrub layer was typically dense with Eurasian honeysuckle, multiflora rose, Japanese barberry, tree-of-heaven, and gray dogwood. Other weedy species such as garlic-mustard, poison-ivy, Virginia creeper, and Oriental bittersweet were common in the ground layer.

Upland hardwood forests that were less disturbed, often due to steep topography or remote location, were characterized by a more mature forest community, with variable mixtures of hardwoods including sugar maple, pignut hickory, shagbark hickory, mockernut hickory, red oak, white ash, American beech, black birch, and tulip tree among the co-dominants. The shrub layer was also variable and patchy in distribution, with maple-leaf viburnum, flowering dogwood, saplings of various maples, oaks, and hickories, witch-hazel, and spicebush among the common species.

The mid- to upper slopes of steep, rocky ridges (e.g. Fishkill Ridge and Honness Mountain in the Fishkill portion of the corridor) supported high quality oak-hickory forest communities, typically dominated by combinations of red oak, black oak, white oak, hickories, and sugar maple. As the elevation increased, total canopy cover decreased from about 90 percent to 65 percent—presumably due to the shallower soils and drier conditions near the ridge top. The shrub layer, which was often sparse, included maple-leaf viburnum and downy arrowwood. The ground layer in these forests was diverse, with common hairgrass, Pennsylvania sedge, and Christmas fern among the typical species.

Ridge summits and other rugged terrain underlain by shale bedrock (e.g. in the northern portion of the LaGrange study area) contained high quality chestnut oak forest communities. Chestnut oak and red oak were the co-dominant species; scarlet oak, black oak, and white oak were less common. The shrub layer was frequently dominated by deciduous heath species, including pale blueberry, lowbush blueberry, and black huckleberry. A few locations also supported mountain laurel, although total cover was low. Ground layer diversity was less than that of the oak-hickory forest, with Pennsylvania sedge and other grasses and sedges among the common species. Exposed bedrock was extensive throughout the chestnut oak forests.

Upland Conifer Forest (ucf)

This habitat includes both naturally-occurring conifer forests and conifer plantations with greater than 75 percent cover of conifer trees. Natural upland conifer forests in the study area were composed of moderately dense stands of white pine, eastern hemlock, or red cedar—typically in the range of 5-8 in (12-20 cm) diameter-at-breast-height (dbh). Old conifer plantations within the study area were frequently dominated by spruce. The shrub and ground layers in these heavily shaded stands were notably sparse and low in overall diversity.

Several small limestone knolls had conifer forests with stands of 4 in (10 cm) dbh eastern red cedar. Although total canopy cover of the cedar was as high as 85 percent, the ground layer was extensive and included a diverse array of shade-tolerant forbs and grasses. Calcicoles (calcium associated species) such as ebony spleenwort were also relatively abundant.

Upland Mixed Forest (umf)

We use the term “upland mixed forest” for upland forests dominated by a mixture of coniferous and deciduous trees, but where neither represents greater than 75 percent of the canopy. Mixed forests in the study area had various deciduous species mentioned above and at least one of the following conifers: white pine, eastern hemlock, red pine, spruces, eastern red cedar, and in one case pitch pine (likely planted). Although these areas were slightly more shaded than pure deciduous forests, they still tended to support a moderately diverse array of understory species.

Upland mixed forests located on steep slopes and hilltops were usually embedded within oak-hickory or chestnut oak forest communities. These high quality mixed forests were dominated by eastern hemlock, chestnut oak, red oak, white oak, sugar maple, hickories, and black birch. Although these forests tended to be cooler and more shaded, they often supported a shrub and herb community similar to that of the neighboring chestnut oak or oak-hickory forest.

Occurrence in the Study Area

Upland Hardwood Forest (uhf)

Upland hardwood forest occurred in all three parts of the study area, although the extent and quality of the forests varied considerably. In the LaGrange portion of the corridor, approximately 42 percent of the landscape was upland hardwood forest. Most of this habitat was concentrated in the hilly terrain north of Route 55, including the largest block of hardwood forest mapped in LaGrange (250 ac [100 ha]) and at least six other blocks each over 100 ac (40 ha). Many of these were high quality chestnut oak forests and several extended beyond the corridor boundary

Upland hardwood forest occupied about 25 percent of the Fishkill portion of the corridor. The single largest block of hardwood forest in the entire study area was located in Fishkill. This 600 ac (243 ha) forest was associated with the northern arm of Fishkill Ridge, just south of Greenwood Drive. The total size of this forest, which extended beyond the corridor, was more than 6,000 ac (2,428 ha). The second largest block of hardwood forest in the Fishkill portion of the corridor was about 145 ac (60 ha) and located along Honness Mountain, just north of Interstate 84. We consider these two large blocks of high quality oak-hickory and chestnut oak forest to be of particular ecological importance.

Upland hardwood forest occupied only 24 percent of the total land area in the Beekman portion of the study area. The two largest blocks of hardwood forest (150 ac and 116 ac [61 and 47 ha]) occurred in the hilly terrain along the western edge of the corridor, just northeast of Sylvan Lake. Both of these were part of larger forest blocks that extend beyond the corridor boundary.

Upland Conifer Forest (ucf)

Although upland conifer forest was documented in all three portions of the study area, it was far less common than other types of forest habitat and individual occurrences were typically small—about 2 ac [0.8 ha] on average. We mapped about 65 ac (26 ha) of conifer forest in the LaGrange portion of the study area and about 25 ac (10 ha) each in the Fishkill and Beekman portions had

Upland Mixed Forest (umf)

We mapped upland mixed forest in the Beekman, LaGrange, and Fishkill portions of the corridor. The study area in LaGrange contained the most upland mixed forest (194 ac [79 ha]), but many individual occurrences were less than 3 ac (1 ha). The largest patch of mixed forest (20 ac [8 ha]) was located within a high quality chestnut oak complex in the extreme northern tip of the corridor.

The Fishkill portion of the corridor supported a total of 185 ac (75 ha) of mixed forest. The average size of individual occurrences was slightly larger at 5 ac (2 ha). Nearly 58 percent of this habitat, including a 62 ac (25 ha) block, was located along the mid and upper slopes of Honness Mountain, just north of Interstate 84. These patches of mixed forest were part of a high quality forest complex.

Mixed forest occupied a smaller fraction of the Beekman study area. Here, we mapped less than 100 ac (40 ha) of upland mixed forest with most occurrences less than 2 ac (0.8 ha). Sixty percent of this habitat was concentrated in the northwest corner of the corridor.

Conservation Considerations

Forests of all types provide important shelter, foraging, and breeding habitat for wildlife. Extensive forested areas that are unfragmented by roads, utility corridors, or developed lots are especially important for certain species that require large blocks of continuous habitat for their survival. Such unfragmented forests are becoming increasingly rare in the region as new roads and residential and commercial development divide extensive forests into smaller and more isolated patches.

Fragmentation of forests can have many negative ecological effects that extend far from the road, residence, or other fragmenting feature. The adverse impacts of a new road through a forest, for example, can extend several hundred meters from the road and affect soil fauna, birds, amphibians, reptiles, mammals, and plant communities (Forman and Deblinger 2000, Trombulak and Fissell 2000, Haskell 2000). These negative impacts include the reduction in size of animal territories, the intrusion of invasive plants and human-adapted predators such as raccoon and striped skunk, the disruption of migration routes of reptiles, amphibians and large mammals, a decrease in abundance and diversity of soil fauna, and an increase in road mortality for many wildlife species in their ordinary daily and seasonal movements.

The loss of extensive forests has been implicated in the declines of numerous species of migratory songbirds (Robbins 1980, Ambuel and Temple 1983, Wilcove 1985, Hill and Hagan 1991), raptors (Bednarz and Dinsmore 1982, Billings 1990, Crocoll 1994), and large mammals (Godin 1977, Merritt 1987). Many birds and mammals of conservation concern are dependent upon large tracts of upland forest, including Cooper's hawk,* red-shouldered hawk,*eastern wood-pewee,* Acadian flycatcher,* wood thrush,* cerulean warbler,* ovenbird,* bobcat,* and fisher* to name just a few.

Some general guidelines for forest conservation include:

1. Protect large, contiguous forested areas wherever possible.
2. Protect areas of mature and old-growth forest.
3. Protect natural conifer stands.
4. Avoid development or other disturbance in forest interiors.
5. Maintain the forest canopy and understory vegetation intact.
6. Maintain standing dead wood, downed wood, and organic debris, and prevent disturbance or compaction of the forest floor.
7. Protect smaller forest patches in strategic locations (e.g. those that provide a connection between larger forest patches, have smaller, unusual habitats embedded in them, or are known to support rare species).
8. Maintain or restore corridors of intact habitat between large forested areas (including connections across roads).

RED CEDAR WOODLAND (rcw)

Ecological Attributes

A red cedar woodland is a former oldfield habitat where eastern red cedar has become prominent in the overstory. Individuals of eastern red cedar are generally small (2–4 in [5-10 cm] dbh) and comprise no more than 65 percent cover. Cedar is often one of the first woody plants to invade abandoned pastures on mildly acidic to alkaline soils in this region. Woodlands on recently abandoned pastures or hayfields tend to have a greater cover of open meadow with young, widely spaced cedar, while those on long-abandoned fields have denser stands of older cedar. The composition of the plant community, especially within the open meadow areas, varies considerably depending on the underlying geology, soil chemistry and moisture, and disturbance history.

In portions of the study area that had Wappinger Group bedrock (e.g. the northeastern end of the Fishkill corridor and most of the Beekman corridor), red cedar woodlands were closely associated with limestone knolls. These areas were often recently abandoned pastures that had reverted to an open woodland community. Networks of grassy openings and small limestone rock outcrops were abundant throughout these habitats. Characteristic species included little bluestem grass, poverty grass, gray goldenrod, tall hairy goldenrod, Canada goldenrod, aster, mountain-mints, selfheal, spotted knapweed, white sweet clover, cinquefoils, spiked lobelia, and field pussytoes, among many others. Calcicole ferns such as ebony spleenwort and purple-stemmed cliffbrake occurred on and near limestone outcrops. Shrubs such as gray dogwood, common buckthorn, Eurasian honeysuckle, and autumn olive were locally abundant in a few of these red cedar woodlands.

Red cedar woodlands on shale bedrock (e.g. in the LaGrange portion of the corridor) had a different plant community and habitat structure than those described above. Below the red cedar canopy was a conspicuous subcanopy or tall-shrub layer composed of red oak, white pine, and black birch, usually comprising no more than 20 percent total cover. The meadow-like openings supported small, dense patches of pale blueberry and lowbush blueberry on the relatively deeper soils along the meadow edge, and little bluestem, Pennsylvania sedge, and various other grasses on shallower soils. Exposed shale bedrock was often covered by a thick carpet of moss.

Occurrence in the Study Area

We documented red cedar woodland in all three portions of the study area. The LaGrange portion had a total of 16 red cedar woodlands ranging in size from less than 1 ac (0.4 ha) to 7 ac (2.8 ha). Seventy-two percent of this habitat was concentrated in several distinct complexes along the east and west sides of Gidley Road in the far northern end of the corridor. Many of the 'mildly acidic' red cedar woodlands (see above) were located in this region. We considered these habitats to be of high quality due to their distinctive plant community and biodiversity potential.

We mapped a total of 11 red cedar woodlands in the Beekman portion of the corridor, ranging from less than 1 ac to nearly 14 ac (0.4 - 5.7 ha). All were confined to the far northwestern end of the Beekman corridor in an area strongly influenced by the underlying limestone

The Fishkill portion of the study area contained a single 9 ac (3.6 ha) cedar woodland located north of Deer Crossing Road in an area underlain by limestone.

Conservation Considerations

Although relatively little is known about the ecology of red cedar woodlands, they are distinct from other wooded habitats in the region and may provide habitat for an unusual suite of species. Red cedar woodlands may provide roosting habitat for several raptors of conservation concern, including northern harrier,* short-eared owl,* and northern saw-whet owl.* Red cedar fruit is a food source for eastern bluebird, cedar waxwing, evening grosbeak, and other birds. Many songbirds also use red cedar for nesting and roosting, and insectivorous birds such as black-capped chickadee and golden-crowned kinglet forage in red cedar. The olive hairstreak,* a regionally rare butterfly, uses red cedar as its primary larval host.

Red cedar woodlands with exposed gravelly or sandy soils may be important nesting habitat for several reptile species of conservation concern, including Blanding's turtle,* wood turtle,* spotted turtle,* eastern box turtle,* and eastern hognose snake.* These reptiles may travel considerable distances overland from their primary wetland or forest habitats to reach the nesting grounds. The eastern hognose snake may also use these habitats for basking, foraging, and overwintering. Cedar woodlands on limestone knolls may contain open “sand pits” that could potentially support rare tiger beetles, land snails, and plants such as Carolina whitlow-grass,* yellow wildflax,* Bicknell’s sedge,* and large twayblade.*

Extensive occurrences of red cedar woodlands are limited in Dutchess County, and some of the high-quality examples in the study area are worthy of protection. Cedar woodlands on abandoned agricultural lands are often considered prime development sites, and thus are particularly vulnerable to direct habitat loss or degradation. Woodlands on steep slopes with fine sandy soils may be especially susceptible to erosion from ATV traffic and other human uses. Such disturbances may also facilitate the invasion of non-native forbs and shrubs that tend to diminish habitat quality by forming dense stands that displace native plant species. Wherever possible, measures should be taken to prevent the direct loss or degradation of these habitats and to maintain unfragmented connections with nearby wetlands, forests, and other important habitats.

UPLAND SHRUBLAND (us)

Ecological Attributes

Upland shrubland is a term we use for many kinds of shrub-dominated upland habitats. In most cases, these lands are transitional between upland meadow and young forest habitat, but they also occur along utility corridors maintained by cutting or herbicide application and in recently cleared areas. Shrub cover is generally greater than 20 percent. Most of the upland shrublands in the study area occurred on former agricultural land or along infrequently maintained power line rights-of-way. The vegetation of these habitats was highly variable in species composition, height, and density depending on the disturbance history, soil conditions, and other factors.

Some shrublands contained dense thickets of mostly non-native shrubs such as Eurasian honeysuckle and multiflora rose. Others were dominated by a mixture of native and non-native shrubs and young trees including eastern red cedar, gray dogwood, black cherry, gray birch, and eastern cottonwood. The ground layer of shrublands varied considerably in species composition, but Canada goldenrod, tall hairy goldenrod, and several grasses were among the common species.

Occurrence in Study Area

Upland shrubland habitat occurred in all three sections of the study area. In the LaGrange portion of the corridor, shrubland habitat encompassed a total of 233 ac (94 ha), with individual occurrences ranging from less than 1 ac to 13 ac (<0.4 - 5.3 ha).

We mapped nearly 200 ac (81 ha) of upland shrubland in the Beekman portion of the corridor, ranging from less than 1 ac to 32 ac (<0.4 - 13 ha). We identified two large shrubland complexes. The northern complex, located just west of Clove Valley Road, was composed of nine mid-sized shrubland patches that totaled more than 31 ac (12.5 ha). The southern complex, located just south of the junction of Green Haven Road and Lime Ridge Road, consisted of three shrubland patches that totaled nearly 68 ac (27.5 ha). We believe these complexes have higher habitat value than others in the study area due to their collective size.

The Fishkill portion of the study area had about 181 ac (73 ha) of upland shrubland, with individual occurrences ranging from less than 1 ac to nearly 23 ac (<0.4 - 9 ha). A 64 ac (26 ha) complex composed of four mid-sized and several smaller shrubland patches occurred near Slocum Road and Route 9D in the far southern end of the corridor.

Conservation Considerations

Many bird species of conservation concern nest in upland shrubland and adjacent upland meadow habitats, including northern harrier,* golden-winged warbler,* yellow-breasted chat,* vesper sparrow,* grasshopper sparrow,* blue-winged warbler,* and clay-colored sparrow.* Extensive upland shrublands and those that form large complexes with meadow habitats may be particularly important for these breeding birds. Several species of hawks and falcons use upland shrublands and adjacent meadows for hunting. Rare butterflies such as Aphrodite fritillary,* dusted skipper,* Leonard's skipper,* and, at higher elevations, cobweb skipper* may occur where their host plants are present. Shrublands and other non-forested upland habitats with loose gravelly soils may be used for nesting by Blanding's turtle,* wood turtle,* box turtle,* spotted turtle,* painted turtle, and snapping turtle. A few species of rare plants are known from calcareous shrublands in the region, such as stiff-leaf goldenrod* and shrubby St. Johnswort.*

While some upland shrublands have reverted to forest habitat, many others have been converted to residential or commercial uses. High quality occurrences that could potentially support rare breeding birds, rare butterflies, or rare plants should be protected from development and other types of human disturbance. For shrublands maintained by brush-hogging or mowing, timing these activities to coincide with the post-fledging season for most birds (e.g. September and later) and only cutting every few years (instead of annually) would reduce the impacts on birds that breed in these habitats.

UPLAND MEADOW (um)

Ecological Attributes

We use the term "upland meadow" very broadly to include hayfields, pastures, and abandoned fields, as well as active cropland (e.g. cornfield) that is tilled and harvested regularly. Upland meadows are typically dominated by grasses and forbs; cover by shrubs is generally less than 20 percent. We include cropland with upland meadow not so much for its current habitat value, but for its potential value. If left uncultivated, cropland areas tend to quickly revert to meadow environments with a much higher habitat value.

Many of the larger upland meadows in the study area were either cattle and horse pasture, and thus highly disturbed, or active cropland with corn as the principal species. The vegetation of other upland meadows varied considerably; some were dominated almost exclusively by tall grasses while others had a mixture of grasses and forbs such as Canada and rough-stemmed goldenrod, several species of aster, Queen Anne's lace, common burdock, daisy fleabane, and numerous others.

Occurrence in the Study Area

Upland meadow occurred in all three segments of the study area, but was most extensive in portions that had active or recently abandoned agriculture. Here, meadows were located in close proximity to one another, often forming large meadow complexes.

We mapped a total of 656 ac (265 ha) of upland meadow in the Beekman portion of the corridor, which accounted for about 17 percent of the Beekman study area. These meadows ranged from less than 1 ac to nearly 54 ac (<0.4 - 22 ha), with an average of 5.6 ac (2.3 ha). A large meadow complex occurred on and in the vicinity of the Green Haven Prison Farm in the southern end of the corridor. This complex was composed of 11 active pastures and cornfields and totaled nearly 206 ac (83 ha). A second complex of moderately sized but somewhat more dispersed upland meadows occurred on recently abandoned or less intensively used agricultural lands north of Route 55.

The LaGrange portion of the corridor had a total of 750 ac (300 ha) of meadow habitat, which accounted for about 12 percent of the LaGrange study area. These meadows ranged from less than 1 ac to 61 ac (<0.4 - 25 ha), with an average of 5.6 ac (2.3 ha). A long, semi-continuous band of pasture and open fields extended northward from Barmore Road to an area just below the junction of Downing Road and Gidley Road. This linear meadow complex contained 348 ac (141 ha) of upland meadow. A second, more widely dispersed complex occurred in the agricultural lands south of Route 55, encompassing 372 ac (151 ha).

The Fishkill portion of the study area contained only 246 ac (100 ha) of upland meadow. These meadows were generally smaller (< 1 ac to 17 ac [<0.4 - 7 ha]; average of 3.4 ac [1.4 ha]) and widely distributed throughout the corridor. A small concentration of meadow occurred on the grounds of the Fishkill Correctional Facility south of Interstate 84.

Conservation Considerations

Upland meadow is a biologically important habitat type that appears to be disappearing at a faster rate than many other habitats in the region. While some upland meadows have simply been abandoned and have reverted to forest, many others have been converted to residential or commercial uses.

Although there can be important habitat value (e.g. for invertebrates and small mammals) in small patches of upland meadow, large patches have especially significant habitat value for grassland breeding birds of conservation concern such as northern harrier,* upland sandpiper,* Henslow's sparrow,* grasshopper sparrow,* vesper sparrow,* eastern meadowlark,* and bobolink.* These species require extensive meadow habitats for successful nesting and foraging. The pronounced decline of grassland-breeding birds in the Northeast has been attributed to the loss of suitable upland meadow habitat (Askins 1993, Vickery 1994, Jones and Vickery 1995). Birds nesting in meadows surrounded by developed land uses are also more vulnerable to a variety of disturbances, including increased nest predation by human-subsidized predators such as raccoon and striped skunk.

Upland meadows with loose soil may be used for nesting by Blanding's turtle,* wood turtle,* spotted turtle,* box turtle*, painted turtle, and snapping turtle. These turtles may travel long distances from their primary wetland or upland habitats to nest in meadows and other open habitats. Several species of rare butterflies, such as dusted skipper,* Leonard's skipper,* swarthy skipper,* and Aphrodite fritillary* depend on upland meadows that support their particular host plants.

Threats to upland meadow habitats include soil compaction and erosion by ATVs, other vehicles, and equipment, which can reduce the habitat values for invertebrates, small mammals, nesting birds, and nesting turtles. Destruction of vegetation can reduce viable habitat for butterflies and rare plants, and mowing of upland meadows during the bird nesting season can cause mortality of nestlings and fledglings. Timing mowing activities to coincide with the post-fledging season for most birds (e.g. September and later) would reduce these negative impacts. The application of pesticides may greatly reduce the capacity of meadows to support biodiversity.

Protecting upland meadow habitats from these and other human disturbances will help to protect sensitive species of conservation concern. Beyond their ecological values, there are many other compelling reasons to conserve active farmland and land with agricultural potential. From a cultural and economic standpoint, maintaining our ability to produce food locally has obvious advantages in the face of unstable and unpredictable energy supplies. Active farms also contribute to the local economy and to the scenic beauty of the town landscape.

OAK-HEATH BARREN (ohb)

Ecological Attributes

The oak-heath barren is an uncommon habitat type typically found on ridge tops, summits, and steep upper slopes where exposed bedrock covers more than 60 percent of the ground surface. The bedrock is hard and acidic, with schist, gneiss, granite, and quartzite among the common types. The soils are extremely thin, excessively well drained, and very nutrient poor. These droughty and infertile conditions have a strong influence on the composition and structure of the plant community. Trees, for example, comprise less than 25 percent cover and are notably stunted, with a dbh of 4 - 8 in (10 - 15 cm) and heights around 6 - 15 ft (2 - 4.5 m). Shrub cover varies depending on the amount of exposed bedrock, but is usually greater than 30 percent and is dominated by scrub oak and heath species. Some oak-heath barrens support a low grassland community characterized by a mixture of drought tolerant grasses, sedges, mosses, lichens, and open rock pavement.

Due to the open canopy, oak-heath barrens tend to have a much warmer microclimate than the surrounding forested habitat, especially in the spring and fall. The exposed nature of these habitats also makes them particularly susceptible to wind, ice, and, at least historically, fire disturbance. Periodic fire in this habitat appears to be an important ecological process that helps control the encroachment of overstory trees and allows for regeneration of characteristic oak-heath barren species. In the absence of fire and other natural disturbance, many oak-heath barrens eventually become ordinary wooded crests.

Chestnut oak, scarlet oak, and red oak were the co-dominant trees in barrens within the study area; other species such as hickories and eastern red cedar were uncommon or localized. A few barrens had pitch pine, a fire dependant tree that was presumably more abundant in this habitat prior to modern forest fire suppression efforts. The tall shrub layer was typically patchy with scrub oak, young red oak, downy arrowwood, red maple, young black birch, and black cherry among the common species. Mountain laurel was a rare component of the shrub layer in a few oak-heath barrens. Lowbush blueberry, pale blueberry, and black huckleberry dominated the lower shrub layer, often forming small thickets in areas with slightly deeper soil. Small grassland openings supported little bluestem, poverty grass, common hairgrass, Indian grass, panic grass, Pennsylvania sedge, white-tinge sedge, downy goldenrod, silverrod, and field chickweed. Mosses, smooth rock tripe, and other lichens often formed thick carpets on portions of the bedrock surface. Ferns such as rock polypody were locally abundant in rock crevices.

Occurrence in the Study Area

Oak-heath barren habitat was confined to the Fishkill and LaGrange portions of the study area. Most barrens were considerably smaller than 1 ac (0.4 ha). We mapped 18 oak-heath barrens in the Fishkill portion of the study area with a total area of 12 ac (5 ha). Half the occurrences were dispersed along the upper ridge line of Fishkill Ridge, just south of Interstate 84. The remaining 9 barrens were found on knolls and summits on Honness Mountain, just north of Interstate 84. The largest oak-heath barren (nearly 3 ac [1.2 ha]) occurred along a power line corridor on Honness Mountain. We considered all of these barrens to have significant habitat value.

The LaGrange portion of the study area contained 7 oak-heath barrens with a total area of more than 3 ac (1.2 ha). The largest barren (2.3 ac [0.9 ha]) spanned the upper slope and crest of a hill just north of Route 55 and east of the Taconic State Parkway. Most of the remaining barrens occurred on lower crests just to the east and west of the Taconic State Parkway. Oak-heath barren habitat in the LaGrange study area had a slightly greater tree cover. However, all barrens still contained at least some high quality grassland and shrub openings with exposed rock outcrops.

Conservation Considerations

Although oak-heath barrens appear quite inhospitable to plants and animals, they often support a number of rare species that are adapted to the dry, exposed conditions or require specialized habitat features associated with rocky outcrops.

Oak-heath barrens can have significant habitat value for several rare snake species, specifically the timber rattlesnake* and the northern copperhead.* Deep rock fissures can provide crucial shelter habitat for these species and the exposed ledges provide basking and breeding habitat in the spring and early summer. Other animals of high conservation concern, such as the northern fence lizard* and five-lined skink,* are dependent on oak-heath barrens and other crest, ledge, and talus habitats (see below) for hibernation, basking, breeding, and foraging. Five-lined skink was observed during this study in an oak-heath barren on Fishkill Ridge in the Fishkill portion of the study area.

A number of rare butterflies that use scrub oak, little bluestem, lowbush blueberry, or pitch pine as their primary food-plant tend to concentrate in barren habitats, including northern hairstreak,* Edward's hairstreak,* Horace's duskywing,* cobweb skipper,* dusted skipper,* Leonard's skipper,* brown elfin,* and eastern pine elfin.* Oak-heath barrens also appear to be refuges for a number of rare oak-dependent moths. Rare plants of oak-heath barrens include reflexed sedge,* clustered sedge,* mountain spleenwort,* and dittany.*

Oak-heath barren habitats are often used by humans as scenic overlooks and some of the more disturbed areas contain campsites, foot paths, ATV trails, and garbage. Trampling, soil compaction, and soil erosion can damage or eliminate rare plants, can discourage use by rare animals, and can encourage invasions of non-native plants. Barrens on ridge tops and summits can be disturbed or destroyed by the construction and maintenance of communication towers. Construction of roads and houses in the valleys between oak-heath barrens can fragment important migration corridors for snakes, lizards, and butterflies, thereby isolating neighboring populations and decreasing their long-term viability. Because rare snakes tend to congregate on oak-heath barrens at certain times of the year, they are also highly susceptible to killing or collecting by poachers. To protect fragile oak-heath barrens and the sensitive species associated with them, activities in the vicinity should be designed to minimize fragmentation, trampling, soil erosion, and direct and indirect disturbance to wildlife.

CREST, LEDGE, and TALUS

Ecological Attributes

Crests and ledges are areas of exposed bedrock, often occurring on hillsides and ridge tops but also found at low elevations. Talus is the mass of rock fragments, blocks, or boulders that often accumulate at the base of steep ledges and cliffs. Crest, ledge, and talus habitats often (but not always) occur together, so are described together here. These habitats are similar to and often occur in close association with the oak-heath barren habitat described above. However, crest, ledge, and talus habitats sometimes have a lower cover of exposed bedrock, a taller plant community with more than 25 percent tree cover, and fewer (if any) scrub oaks and heaths in the shrub layer. The exact composition of the plant community is often quite variable and appears to be determined by factors such as the bedrock type and extent of exposure, soil depth, moisture, aspect, slope, and disturbance history.

In the study area, the more extensive occurrences of crest, ledge, and talus supported a distinct plant community. The upper canopy usually ranged from 40 to 75 percent total cover, and included red oak, chestnut oak, red maple, sugar maple, pignut hickory, and eastern hemlock. Tall shrubs included scrub oak, small stems of other oaks, shadbush, and spicebush, while low blueberry and pale blueberry occupied the low shrub layer. The ground layer was highly variable, but Pennsylvania sedge, little bluestem, common hair grass, poverty grass, downy goldenrod, and white wood aster were among the common species. Smooth rock tripe and other lichens frequently covered 25 percent or more of the rock surface. We observed pink lady's slipper in several crest habitats on shale bedrock.

Occurrence in Study Area

Crest, ledge, and talus habitats occurred in variable amounts in all three parts of the study area. The Fishkill portion of the corridor contained the greatest amount, with more than 1000 ac (405 ha) concentrated in the steep granite and gneiss terrain of Fishkill Ridge and Honness Mountain. We consider these rocky summits and talus slopes to have exceptional habitat value due to their extent, condition, and location within large forested areas. An area along the northeast slope of Fishkill Ridge was particularly noteworthy due to its near vertical cliff face and extensive talus slope.

Crest, ledge, and talus in the LaGrange portion of the corridor occurred primarily along the shale and schist ridges that flank Sprout Creek. Most was north of Route 55, particularly along the western edge of the corridor. These habitats, which consisted largely of small to mid-sized rock outcrop with little talus, were frequently associated with high quality chestnut oak forests. Rock outcrop/chestnut oak associations may have a unique biodiversity value not found elsewhere in the study area.

The Beekman portion of the study area contained only a few small patches of crest, ledge, and talus located along the western edge of the corridor between Route 55 and Martin Road.

Conservation Considerations

Crest, ledge, and talus provide key habitat for a number of vulnerable plants and animals. Potential rare plants of these habitats include reflexed sedge,* mountain spleenwort*, clustered sedge,* slender knotweed,* and eastern prickly-pear.* The regionally rare slimy salamander* occurs in wooded talus, and northern hairstreak* (butterfly) occurs with oak species, its larval hosts. Breeding birds of acidic crest habitats include cerulean warbler,* worm-eating warbler, and blackburnian warbler.* The timber rattlesnake,* northern copperhead,* fence lizard,* five-lined skink,* and black racer* use crest, ledge, and talus for foraging and shelter habitat. Bobcat and fisher are two vulnerable species that use high-elevation crests and ledges for travel, hunting, and cover. Bobcat also uses talus habitats for denning.

Crest, ledge, and talus habitats often occur in locations that are valued by humans for scenic vistas and house sites. Construction of roads and houses destroys crest, ledge, and talus habitats directly, and causes fragmentation of these habitats and the forested areas of which they are a part. Rare plants of crests are vulnerable to trampling and collecting and rare breeding birds of these habitats can be easily disturbed by human activities nearby. Rare snakes are vulnerable to killing or collecting, to the loss of denning and breeding habitats, and to disruption of their foraging areas and movement corridors. The shallow soils of these habitats are especially susceptible to erosion from construction and logging activities, and from foot and ATV trails. To protect fragile crest, ledge, and talus habitats and the sensitive species associated with them, activities in the vicinity should be designed to minimize fragmentation, soil erosion, and direct and indirect disturbance to wildlife.

CALCAREOUS CREST, LEDGE, and TALUS

Ecological Attributes

Calcareous crest, ledge, and talus habitats are similar to the previous habitat type except that the exposed bedrock is calcareous, typically limestone in this study area. The soils surrounding these outcrops are highly calcareous and tend to be very shallow and well drained. Areas mapped as calcareous crest, ledge, and talus consisted mostly of small limestone outcrops, exposed limestone pavement, and a few small limestone ledges. Only one area south of Furnace Pond in the Beekman portion of the corridor contained an appreciable amount of calcareous talus; this talus appears to be the result of historic limestone mining for a former iron furnace.

The limestone bedrock had a strong influence on the plant community of these areas. Some of the more conspicuous areas were associated with the red cedar woodland habitat described above. Other occurrences were associated with forest and meadow habitats. Ebony spleenwort, maidenhair spleenwort, purple cliffbrake, herb-Robert, wild columbine, and other calcicoles were abundant on and near higher quality outcrops, while more disturbed areas were dominated by non-native species such as garlic-mustard and Japanese barberry.

Occurrence in the Study Area

We documented calcareous crest, ledge, and talus in the Beekman and Fishkill portions of the study area. Most of these occurrences were very small, often encompassing just a few rock outcrops on a knoll or hillside feature in the low-lying portions of the landscape. The greatest extent of calcareous crest, ledge, and talus (about 25 ac [10 ha]) occurred in the vicinity of Furnace Pond in the northern end of the Beekman corridor.

Although we did not document calcareous crest, ledge, and talus in the LaGrange portion of the corridor, some of the shale crests and ledges that we did not observe in the field might be somewhat calcareous. A more detailed site-by-site assessment of these areas should be conducted where needed.

Conservation Considerations

Calcareous crest, ledge, and talus habitats frequently support a collection of habitat-specialized and increasingly rare species. Ferns such as smooth cliffbrake* and walking fern* are associated with crevices in the rock face, while other rare plants such as northern blazing-star,* small-flowered crowfoot,* yellow harlequin*, and Carolina whitlow-grass* may occur in openings adjacent to the rock outcrops. The larger fissures, cavities and exposed ledges may provide shelter, den, and basking habitat for eastern hognose snake,* northern copperhead,* worm snake,* and five-line skink.* Rare butterflies such as olive hairstreak* are largely restricted to crests that support their particular host plants. These habitats may also support a diverse land snail community.

Calcareous crest, ledge, and talus habitats often occur in the valley regions of the county, typically associated with the fertile farmland. These areas are under particularly strong development pressure and many of these habitats have been significantly altered. Construction of roads and houses may destroy calcareous crest, ledge, and talus habitats directly, and cause fragmentation of these habitats and the forested areas of which they are a part. The shallow soils of these habitats are especially susceptible to erosion from construction activities. To protect fragile calcareous crest, ledge, and talus habitats and the sensitive species associated with them, activities in the vicinity should be designed to minimize fragmentation, soil erosion, and direct and indirect disturbance to wildlife, and to maintain habitat connections between crest occurrences.

CLAY BLUFF and RAVINE (cbr)

Ecological Attributes

Clay bluff and ravine habitats occur on clayey soils near the Hudson River and are characterized by steep-sided ravines cut by small streams, and steep bluffs fronting the river. The silty clay loam soils typically belong to the Hudson-Vergennes soil series and are deep and somewhat calcareous. These ravines and bluffs are often eroded or otherwise unstable with areas of slumping or sliding of the surface soil layers. Slumping may produce step or terrace-like features, while sliding may produce smooth, sparsely vegetated scars with soil accumulations at their bases. Clay bluffs and ravines support a variety of other upland habitat types such as hardwood or mixed forest and upland shrubland.

Clay bluff and ravine habitats in the study area were forested, with sugar maple, red oak, white oak, mockernut hickory, shagbark hickory, eastern cottonwood, and American elm among the co-dominant species. A few weedy areas contained abundant Eurasian honeysuckle and Oriental bittersweet.

Occurrence in the Study Area

Clay bluff and ravine habitat was confined to the Fishkill portion of the study area. We mapped a single 9 ac (3.6 ha), clay bluff habitat along the bank of Fishkill Creek, just west of South Avenue. A 21-acre (8.5 ha) clay ravine was located just north of Victoria Lane.

Conservation Considerations

Leatherwood* and goldenseal* have been found in Dutchess County clay ravines. Northern white cedar is nearly restricted in this region to clay bluffs, rocky shores, and shoreline ledges, and wetlands of the Hudson River. Extensive areas of forested clay bluffs and ravines or those with large trees may support breeding Cooper's hawk,* barred owl,* fish crow,* black-throated green warbler,* black-throated blue warbler,* cerulean warbler,* or winter wren.* Trees of clay bluffs that front on the Hudson River or on large bays of the river are used by bald eagle, osprey, and fish crow for hunting perches.

The soils of clay bluff and ravine habitats are very prone to erosion, slumping, and sliding, especially where natural or artificial disturbance has occurred, such as blowdowns, clearing of forest vegetation, ATV use, or foot trail or bike trail construction and use. Areas of disturbed clayey soils are also vulnerable to invasive plant incursions. Maintaining a forested canopy and an undisturbed forest floor will help to protect the biodiversity potential of these habitats.

ORCHARD/PLANTATION (or/pl)

This habitat includes actively maintained or recently abandoned fruit orchards, Christmas tree farms, and other young conifer or hardwood plantations. Conifer plantations with larger, more mature trees were mapped as "upland conifer forest." In the study area, we mapped a single complex of orchard/plantation habitat just south of Apple Tree Lane in Beekman. This complex consisted of three fields totaling 96 ac (39 ha) with apple and other fruit trees. We mapped this as an ecologically significant habitat type more for its future ecological value after abandonment than its current values, which are often compromised by frequent mowing, application of pesticides, and other human activity. These habitats have some of the vegetation structure and ecological values of upland meadows and upland shrublands, and will ordinarily develop into young forests if left alone after abandonment. Cavities in old fruit trees may be used by certain birds, bats, and other animals.

CULTURAL (c)

We define cultural habitats as areas that are significantly altered and intensively managed (e.g. mowed), but are not otherwise developed with pavement or structures. Cultural areas in the study area included several town recreational facilities and parks, school playgrounds, and large lawns. Even though the current ecological value of these areas is reduced by frequent mowing, application of pesticides and fertilizers, and other types of management, they hold potential habitat value if abandoned. Many cultural areas are valuable for open space and provide ecological services such as buffering areas of natural habitat from developed areas and linking patches of undeveloped habitat together. Because they are already significantly altered, however, it may be preferable to site new development in these areas instead of in relatively undisturbed habitats.

WASTE GROUND (wg)

Waste ground is our term for land that has been severely altered by previous or current human activity, but lacks pavement or structures. These areas have been stripped of vegetation and topsoil or have been filled with soil or debris but remain largely unvegetated. We applied this term to several areas that had excavated gravel pits or mounds of bare soil and discarded asphalt. The most extensive waste ground was associated with an active gravel mine just north of Route 55 in LaGrange.

Although waste ground often has low habitat value, there are notable exceptions. Several snake and turtle species of conservation concern, including eastern hognose snake,* Blanding's turtle,* and wood turtle,* may use the open, gravelly areas of waste grounds for burrowing, foraging, or nesting habitat. Several rare plant species are also known to inhabit waste ground environments, including rattlebox* slender pinweed,* and slender knotweed.* Rare lichens may potentially occur in some waste ground habitats. The biodiversity value of waste ground will often increase over time as it reverts to a higher quality habitat.

NONTIDAL WETLAND and STREAM HABITATS

HARDWOOD & SHRUB SWAMP (hs)

Ecological Attributes

A swamp is a wetland community dominated by woody vegetation—trees or shrubs. We combined forested hardwood and shrub swamps into a single habitat type because the two often occurred together and were often difficult to separate using remote sensing. We mapped conifer swamps as a separate habitat type, however, because they were easily distinguished from hardwood swamps on aerial photographs. Hardwood and shrub swamp habitats in the study area varied considerably in their physical and biological characteristics depending on their location in the landscape, hydrology, soil type, intensity and frequency of disturbance (both natural and human disturbance), and other factors.

Large tracts of hardwood and shrub swamp occurred along the broad floodplains adjacent to Fishkill Creek and Sprout Creek. The plant community of these swamps was moderately diverse due, in part, to differences in local flood regime. Green ash, red maple, silver maple, and American elm were among the dominant tree species; swamp white oak, pin oak, eastern cottonwood, and sycamore were less common or localized. Several floodplain swamps had mature trees with diameters greater than 20 in (50.8 cm). Shrub cover varied from less than 25 percent in the more frequently flooded areas to nearly 75 percent in the more elevated portions of the floodplain. Typical species included spicebush, saplings of green ash and American elm, speckled alder, silky dogwood, northern arrowwood, willows, and winterberry. The ground layer was diverse and variable with ostrich fern, skunk-cabbage, and false hellebore among the dominant herbs in the more flood prone areas. Other ground layer taxa included tussock sedge, spotted touch-me-not, false-nettle, sedges, asters, sensitive fern, cinnamon fern, and royal fern. Debris dams, scour lines, deposits of fine alluvial material, and other signs of overland flow were extensive in these swamps.

Outside the floodplains, several shrub swamps supported a plant community not found in the floodplain swamps. These were dominated by highbush blueberry, swamp azalea, swamp rose, young red maple, and extensive carpets and hummocks of *Sphagnum*. Hardwood and shrub swamps influenced by calcareous groundwater were characterized by abundant calcicoles including spreading goldenrod, yellow sedge, golden ragwort, and poison sumac. Disturbed swamps contained non-native shrubs and herbs such as Eurasian honeysuckle, multiflora rose, Japanese barberry, and garlic-mustard.

Occurrence in the Study Area

Hardwood and shrub swamps were the most extensive wetland habitat type in all three portions of the study area. Some swamps were contiguous with marsh and wet meadow habitat and often formed large wetland complexes in low lying portions of the corridor. Smaller swamps were spread throughout the corridor along drainageways and in small depressions.

We mapped a total of 286 ac (116 ha) of hardwood and shrub swamp in the Beekman portion of the corridor, with individual occurrences ranging from smaller than 1 ac (0.4 ha) to nearly 72 ac (29 ha). Approximately 75 percent of this habitat was directly associated with the floodplain of Fishkill Creek, with most located in the southern end of the corridor near the Green Haven Prison Farm. The two largest swamps (NYS wetland PQ-8 and PQ-47) were located on the Green Haven farm property.

The LaGrange portion of the study area contained 651 ac (263.5 ha) of hardwood and shrub swamp, with individual occurrences ranging from less than 1 ac to 97 ac (<0.4 -39 ha). Over 60 percent of this habitat was directly associated with the Sprout Creek floodplain, including the largest occurrence (NYS wetland PV-53) located east of Robinson Lane in the southern end of the corridor. The boundary of this wetland is particularly complex and is only approximated on the habitat map.

We documented nearly 528 ac (214 ha) of hardwood and shrub swamp in the Fishkill portion of the corridor, with individual occurrences ranging from smaller than 1ac to 94 ac (<0.4 - 38 ha). About 57 percent of this habitat was directly associated with the undeveloped portions of the Fishkill Creek and Sprout Creek floodplains. The largest occurrence (NYS wetland WF-23) was located along the Fishkill Creek floodplain just north and south of Interstate 84.

Conservation Considerations

Hardwood and shrub swamps are important habitats for a wide variety of species, especially when the swamp is contiguous with other wetland types or embedded within large areas of upland forest. Rare or declining birds such as the red-shouldered hawk,* barred owl,* great blue heron,* wood duck,* prothonotary warbler,* Canada warbler,* and white-eyed vireo* are potential nesters in large hardwood swamps. Pools within swamps are used for breeding by a variety of amphibian species, including the blue-spotted salamander.* Four-toed salamander,* believed to be regionally rare, breeds in swamps with abundant moss-covered logs and hummocks. Hardwood and shrub swamps along the floodplain of clear, low-gradient streams can be an important habitat component for wood turtle.* Several wood turtles were observed in floodplain swamps in LaGrange and Beekman during this study. Other turtles such as Blanding's turtle,* spotted turtle,* and box turtle* frequently use swamps for summer foraging and winter hibernation. Swamps in low-lying valleys are often heavily used as travel corridors by these turtles as they move between upland nesting areas, drought refuge pools, summer foraging wetlands, and overwintering wetlands.

Swamp cottonwood* is a very rare tree of hardwood swamps and is known from at least one location in the LaGrange portion of the study area. Some of the other rare plants associated with swamp habitats include dwarf huckleberry,* southern dodder*, and ostrich fern.* Ostrich fern is also the primary host of the rare ostrich fern borer moth.*

Many of the small swamps in the study area are embedded in larger areas of upland forest. Most of the larger swamps, however, are located in low-elevation areas where human land uses are also concentrated. Many are surrounded by open agricultural areas or bordered by roads and development. Maintaining the water quality, quantity, and flow patterns in swamps is important to the plants and animals of swamp habitats. For those swamps surrounded by agricultural land, it is important that runoff contaminated with agricultural nutrients and chemicals does not enter the swamps. This can degrade the water quality, affecting both the ecological condition of the swamp and associated streams, and the quality of drinking water if the swamp is connected to a public water supply.

Maintaining connectivity between swamp habitats and adjacent upland and wetland habitats is essential to amphibians that breed in swamps and to other resident and transient wildlife of swamps. Direct disturbance, such as construction activity, creation of ponds, and logging can damage soil structure, plant communities, and microhabitats, and provide access for invasive plants.

CONIFER SWAMP (cs)

Ecological Attributes

Conifer swamp is a special type of forested swamp habitat (see above) where conifer species occupy 75 percent or more of the upper tree canopy. The dense canopy has a strong influence on the plant community and habitat structure of these swamps. The shrub and herbaceous layers, for example, are typically sparse and low in species diversity due to the heavy shading. Shading also creates a cooler microclimate, thereby allowing snow and ice to persist longer into the early spring growing season. Conifers growing in wetlands frequently have very shallow root systems and are therefore prone to windthrow. The resulting tip-up mounds, root pits, and coarse woody debris all contribute to the habitat's complex structure and microtopography.

Eastern red cedar was the dominant species in conifer swamps in the study area. Deciduous trees such as green ash, American elm, and red maple were present, but less abundant. The shrub and herbaceous layers were similar in species composition to those of hardwood and shrub swamps, but the overall cover was considerably lower.

Occurrence in the Study Area

We documented a few conifer swamps in the Fishkill and LaGrange portions of the study area. The Fishkill portion contained a total of 4.5 ac (1.8 ha) of conifer swamp, with individual occurrences ranging from less than 1 ac to 2 ac (<0.4 - 0.8 ha). These occurred in two different wetland complexes in the east-central portion of the corridor. In the LaGrange study area, we mapped only two small occurrence of conifer swamp (totaling 0.3 ac [0.1 ha]) along the Sprout Creek floodplain in the northern half of the corridor.

Conservation Considerations

Conifer swamps are uncommon in the Hudson Valley, and may support rare plants, insects, birds, and other biota. Tamarack swamps are often near fens or fen-like habitats, and may support some of the rare species of fens. Barred owl is known to nest in conifer swamps that are part of a larger forest matrix. These habitats share many of the sensitivities of hardwood swamps, and are easily damaged by logging and other intrusive activities that damage soil structure, vegetation, and microhabitats.

MARSH (ma)

Ecological Attributes

A marsh is a wetland dominated by herbaceous (non-woody) vegetation that typically has standing water for most or all of the growing season. Water depths can range from a few inches to 3 ft (1 m) or more. The composition of the plant community varies with depth and duration of standing water, nutrient availability, and other factors. There is often a layer of well decomposed organic muck over a mineral soil. Marshes often occur at the fringes of deeper water bodies (e.g. lakes and ponds), streams, or within and adjacent to other wetland habitats such as hardwood swamps. The edges of marshes, where standing water is less permanent, often grade into wet meadows.

Many marshes in the study area were associated with dredged or artificially impounded wetlands. Several marshes were apparently created to serve as stormwater treatment basins. These were typically dominated by non-native species such as purple loosestrife and common reed. Less disturbed marshes contained a somewhat more diverse plant community with cattail, water plantain, small forget-me-not, beggar-ticks, bulrushes, rice-cutgrass, tussock sedge, marsh fern, and spotted joe-pye-weed among the common taxa. Marshes in the study area were relatively shallow, with spring and mid-summer water depths of 4-12 in (10-30 cm).

Occurrence in the Study Area

Marsh habitat was uncommon in the study area. We mapped less than 50 ac (20 ha) of marsh, with most occurrences smaller than 1 ac (0.4 ha). Most marshes were highly disturbed and dominated by dense stands of non-native species.

The Fishkill portion of the study area contained the most marsh with a total of 26 ac (10.5 ha). The LaGrange and Beekman portions of the corridor had nearly 12 ac (5 ha) and 10 ac (4 ha), respectively. These habitat units generally ranged from less than 1 ac to nearly 5 ac (<0.4 - 2 ha).

We considered one marsh in the Beekman portion of the corridor to have especially high habitat value. This 2.8 ac (1 ha) marsh was part of an extensive, high quality wetland complex composed of calcareous wet meadow and fen located just west of the junction of Hynes Road and Beach Road. Unlike many other marshes in the study area, this marsh was dominated by an array of native species and had a well-developed habitat structure.

Conservation Considerations

High quality marsh is uncommon in the region. These habitats often support a diverse array of common and rare species. For example, marshes provide crucial nesting or nursery habitats for marsh birds and waterfowl such as Virginia rail,* sora,* king rail,* least bittern,* American bittern,*, marsh wren,* American black duck,* and wood duck.* Many raptor, wading bird, and mammal species use marshes for foraging. Marshes are also important habitats for reptiles and amphibians, including spotted turtle,* northern leopard frog, northern water snake, eastern painted turtle, and snapping turtle. Blanding's turtle* uses marshes for summer foraging, drought refuge, and rehydration during nesting migrations.

Several rare plant species are known from emergent marshes in the region, including buttonbush dodder* and spiny coontail.* Marshes may also support a diverse dragonfly and damselfly community including rare species such as New England bluet.*

Marshes are sensitive to various stresses from offsite (upgradient) sources. Nutrient pollution, contaminated stormwater runoff, and sedimentation can lead to changes in the plant and animal communities of marshes, including the invasion of non-native plants such as purple loosestrife and common reed. Noise and direct disturbance from human activities can discourage breeding activities of marsh birds. Because many animal species of marshes depend equally on surrounding upland habitats for their life history needs, protection of the ecological functions of marshes must include protection of surrounding habitats.

FEN (f)

Ecological Attributes

A fen is an open herbaceous and low shrub wetland that is fed by calcareous groundwater seepage. Fens are characterized by a distinctive plant community dominated by calcicoles, low and sometimes sparse vegetation, a tussocky ground surface, and shallow rivulets and pools. Fens in this region are concentrated in areas underlain by marble or limestone bedrock and are frequently adjacent to upland soils derived from calcareous glacial till. Fens are a rare habitat type because the distribution of calcareous bedrock, soils, and groundwater seepage is limited, and because of historic alteration of wetlands.

Fens in the study area had not been recently grazed or mowed and many contained dense tall-shrub thickets. All fens, however, still contained high quality openings with diverse herbaceous plant communities. Common forbs included marsh fern, grass-of-parnassus, small flowered agrimony,* spotted joe-pye-weed, hog-peanut, tall meadow rue, skunk-cabbage, spreading goldenrod, bog goldenrod, purple-stemmed aster, and golden ragwort among numerous other species. Sedges and grasses were diverse and quite abundant in most fens. Common species included porcupine sedge, yellow sedge, interior sedge, bristly-stalked sedge, woolly-fruit sedge, lakeside sedge, rice-cutgrass, and blue-joint grass.

Shrubby cinquefoil and northern gooseberry were the dominant species in the low shrub layer with most individuals less than 3 ft (1 m) in height. The tall shrub layer (shrubs between 5-10 ft [1.5 - 3 m] in height) included speckled alder, poison sumac, red cedar, silky dogwood, silky willow, and saplings of red maple. At least one fen also contained a moderate number of swamp birch* in the tall shrub layer. Young red maple and American elm, 3-5 in (7.6 - 12.7 cm) dbh, were widely scattered throughout several fens, but their total cover was generally 5 percent or less. Cover by invasive plants such as purple loosestrife and common reed was low.

Occurrence in the Study Area

We documented fen habitat only in the Beekman portion of the study area. All 10 of these fens were concentrated in the northern tip of the Beekman corridor, extending from just south of Route 55 northward to the town boundary. This region, which was strongly influenced by the underlying Wappinger Group limestone, also contained clusters of other important habitats such as calcareous wet meadows and calcareous crest, ledge, and talus. While most fens were smaller than 7 ac (3 ha), the largest fen encompassed nearly 14 ac (5.6 ha). Despite the advanced successional stage of these fens, we considered all to be high quality habitat due to their especially diverse plant communities, low invasive species cover, close proximity to one another, and high potential for successful long-term management.

Conservation Considerations

Fens are one of the most biologically diverse habitats in the Hudson Valley, but they are also one of the most imperiled due to their overall rarity and their sensitivity to disturbance. Because of their unusual chemistry, hydrology, and structure, fens provide habitat to an array of highly specialized species. Many of these species are restricted to fens and so may be quite vulnerable to extirpation.

Fens are the core habitat for the endangered bog turtle* in southeastern New York. The exposed tussocks provide critical basking and nesting microhabitats for this turtle in spring and early summer, and the deep, soft substrate is used for estivation and hibernation at other times of the year. Adjacent marshes, wet meadows, and swamps also provide important summer refuge and winter hibernation habitat, and are considered essential parts of the bog turtle habitat complex.

Fens are also used by other reptiles of conservation concern such as the spotted turtle* and ribbon snake.* The rare sedge wren* nests almost exclusively in shallow, sedge dominated wetlands like fens. Large open fens, especially those associated with extensive meadow complexes, can also be important hunting areas for the northern harrier.* Rare butterflies such as Dion skipper* and black dash,* as well as rare dragonflies such as forcipate emerald* and Kennedy's emerald,* are largely restricted to fen habitats.

More than 12 different plants of conservation concern are found almost exclusively in fen habitats, including bog valerian,* scarlet Indian paintbrush,* handsome sedge,* Schweinitz's sedge,* ovate spikerush,* spreading globeflower,* and swamp birch.* A population of swamp birch was observed in a fen in Beekman during this study.

Fens are highly vulnerable to degradation from activities in nearby upland areas. Nutrient pollution from septic systems, fertilizers, or road runoff, disruption of groundwater flow from wells or excavation, sedimentation from construction activity, or direct physical disturbance can lead to changes in the character of the habitat, including a significant decline in overall plant diversity and invasion by non-native species and tall shrubs (Aerts and Berendse 1988, Panno et al. 1999, Richburg et al. 2001, Drexler and Bedford 2002). Such changes can render the habitat unsuitable for the bog turtle and other fen animals and plants that require the special structural, chemical, or hydrological environment of an intact fen.

Fens that are known to harbor the bog turtle or may serve as potential habitat for the turtle require special protective measures. The US Fish and Wildlife Service (Klemens 2001) recommended not only protecting the actual wetland complex, but also prohibiting development (e.g. roads, driveways, residences, sewer lines, storm water basins, and other structures), mining, herbicide, pesticide, or fertilizer application, and delineation of lot lines within a 300 ft (91 m) distance from the wetland boundary. This buffer may be crucial to safeguarding the wetland habitat quality, hydrology, and turtle travel corridors. We believe that maintaining safe travel corridors between suitable fen habitats is important for population dispersal and to accommodate turtles displaced from degraded habitats. Measures aimed at protecting the bog turtle and its habitat would also help protect the numerous other rare species associated with fens.

WET MEADOW (wm)

Ecological Attributes

A wet meadow is a wetland characterized by a herbaceous (non-woody) plant community and a hydroperiod (duration of flooding) intermediate between that of an upland meadow and a marsh. Wet meadows generally lack standing water for most of the year and frequently become quite dry by mid-summer. The surface soils are saturated long enough, however, to promote the establishment of wetland forbs and graminoids. Wet meadows typically occur along the drier edges of swamps and marshes, or in shallow depressions in upland meadow habitats.

Wet meadows in the study area were generally located near intensive human activity (e.g. agricultural or recreational use) and therefore tended to be more chronically disturbed than other wetlands in the study area. Many had dense stands of one or more invasive species such as reed canary grass, common reed, or purple loosestrife. Less disturbed areas contained native species such as sensitive fern, tussock sedge, fox sedge, other sedges, soft rush, various grasses, arrow-leaved tearthumb, skunk-cabbage, late goldenrod, Canada goldenrod, lance-leaved goldenrod, and asters. Ostrich fern was abundant in a few wet meadows along the Sprout Creek floodplain. Low to mid-sized shrubs were generally patchy (never more than 50 percent cover) and included willows, red maple, elms, and silky dogwood.

Occurrence in the Study Area

We documented wet meadow habitat in all three portions of the study area. The LaGrange portion contained the most wet meadow with a total of nearly 135 ac (55 ha). Individual occurrences ranged from less than 1 ac to more than 21 ac (<0.4 - 8.5 ha). More than 50 percent of the wet meadow habitat occurred within the immediate floodplain of Sprout Creek. These floodplain wet meadows often formed large complexes with hardwood swamp, especially north of Route 55. Many wet meadows in the Sprout Creek floodplain supported a moderately diverse plant community with a low cover of invasive species.

The Fishkill portion of the study area had nearly 68 ac (27.5 ha) of wet meadow, with individual meadows ranging from less than 1 ac to 15 ac (<0.4 - 6 ha). Over 60 percent of this habitat was associated with the immediate floodplain of Fishkill Creek. Despite the highly disturbed condition of the surrounding landscape, some of these floodplain meadows were of good quality with a low cover of invasive species.

We mapped nearly 71 ac (29 ha) of wet meadow in the Beekman portion of the study area, ranging from less than 1 ac to nearly 7 ac (<0.4 - 2.8 ha). Most wet meadows were scattered throughout the active agricultural region in the southern end of the corridor, near the Green Haven Prison Farm. All were dominated by dense stands of invasive species.

Conservation Considerations

Wet meadows share many of the habitat values of upland meadows (see above). Wet meadows can provide nesting and foraging habitat for songbirds such as sedge wren,* wading birds such as American bittern,* and raptors such as northern harrier.* Wet meadows that are part of extensive meadow areas (both upland and wetland) may be especially important to species of grassland breeding birds that have suffered from loss of habitat throughout the Northeast. Wet meadows with diverse plant communities may have rich invertebrate faunas. Blue flag and certain sedges and grasses of wet meadows are larval food plants for a number of regionally-rare butterflies, including mulberry wing,* black dash,* two-spotted skipper,* and meadow fritillary.* Large and small mammals, including the regionally rare southern bog lemming,* use wet meadows and a variety of other habitats for foraging.

Wet meadows are often part of larger complexes of meadows and upland shrubland habitats that are prime sites for development, but they are often omitted from state, federal, and site-specific wetland maps and are frequently overlooked in the environmental reviews of development projects. Wet meadows should be accurately delineated and mapped, and they should be regarded as potentially important habitats during the environmental review process.

CALCAREOUS WET MEADOW (cwm)

Ecological Attributes

A calcareous wet meadow is a special type of wet meadow habitat (see above) that is strongly influenced by calcareous groundwater and soils. These conditions favor the establishment of a calcicolous plant community. Calcareous wet meadows are often associated with the dryer margins of calcareous swamps and fens or are located in close proximity to these habitats.

Calcareous wet meadows in the study area supported a diverse plant community composed of calcicoles such as spreading goldenrod, small flowered agrimony,* drooping bulrush, yellow sedge, porcupine sedge, woolly-fruit sedge, and Bush's sedge.* Several were dominated by dense stands of lakeside sedge and sweetflag. Shrubs indicative of highly calcareous conditions, such as shrubby cinquefoil and beaked willow, occurred at a very low density in a few of these habitats. Other common species included field horsetail, marsh fern, sensitive fern, tussock sedge, fox sedge, meadow sedge, pointed broom sedge, hop sedge, spotted touch-me-not, false-foxglove, dodders, spotted joe-pye-weed, and late goldenrod. Little standing water was observed during spring field visits, but the soils were saturated.

Occurrence in the Study Area

We documented calcareous wet meadow in variable amounts in all three segments of the study area. Calcareous wet meadows cannot be distinguished from an ordinary wet meadow by remote sensing and so must be confirmed in the field. It is possible, therefore, that some of the "wet meadows" we mapped but did not field check were calcareous.

The Beekman portion of the study area contained the most calcareous wet meadow with a total of approximately 18 ac (7.3 ha). Individual meadows ranged from less than 1 ac to 11.4 ac (<0.4 - 4.6 ha). Most calcareous wet meadows were concentrated in the northeastern end of the Beekman corridor. Many were contiguous with or closely associated with other calcareous habitats such as fens. We considered these calcareous wet meadows, especially the largest one, to be high quality habitat with high biodiversity potential.

We documented a total of 8 ac (3.2 ha) of calcareous wet meadow in the LaGrange portion of the study area, with individual occurrences ranging from less than 1 ac to 5.5 ac (<0.4 - 2.2 ha). Nearly 79 percent of this habitat was concentrated in a single area along Sprout Creek, just north of Noxon Road. This large calcareous wet meadow complex was considered to be of high quality due to its extent and condition.

The Fishkill portion of the study area contained a single, 14.5 ac (6 ha) occurrence of calcareous wet meadow, located just north of Deer Crossing Road in the eastern half of the corridor. The potential biodiversity value of this habitat was diminished somewhat by dense stands of purple loosestrife.

Conservation Considerations

Calcareous wet meadows that are part of larger meadow complexes share many of the habitat values of large upland meadows (see above). High quality calcareous wet meadows with diverse native plant communities may support some of the rare plants of fens, such as Schweinitz's sedge* and scarlet Indian paintbrush,* and several rare butterflies if their host plants are present. Ribbon snake* and spotted turtle* are also known to use calcareous wet meadows for basking, foraging, and nesting.

Bog turtles* use calcareous wet meadows that are adjacent to fens for summer foraging and even nesting habitat. Therefore, we recommend that calcareous wet meadows near suitable fens be treated as potential bog turtle habitat and given the same level of protection as fens, including a 300 ft (91 m) buffer zone (see discussion in the "Fen" section).

Calcareous wet meadows share with fens many of the same sensitivities to disturbance. They are particularly vulnerable to nutrient enrichment and siltation, which often facilitate the spread of invasive species. In addition, because calcareous wet meadows tend to be on the drier end of the wetland continuum, they are often omitted from state, federal, and site-specific wetland maps and are frequently overlooked in the environmental reviews of development projects. Calcareous wet meadows should be accurately delineated and mapped, and should be regarded as potentially significant habitats during the environmental review process.

WET CLAY MEADOW (wcm)

Ecological Attributes

A wet clay meadow is a special type of wet meadow habitat (see above) that occurs on level terrain with deep silty clay loam and clay loam soils of glaciolacustrine (glacial lake) origin. The clayey soils are generally calcareous and low in organic matter, and have low permeability. Like other wet meadows, wet clay meadows tend to dry up by mid- to late summer. The soils of some wet clay meadows may experience regular swelling and shrinkage at their surface as they become saturated in the spring and then dry out in summer. The wetland plant community is often similar to that of other wet meadows, but usually includes other species such as false foxglove, small flowered agrimony, meadow sedge, and Bush's sedge.

Wet clay meadow habitat in the study area had open graminoid and forb communities with smaller patches of shrubs and young trees. The ground layer was particularly diverse, and included an array of sedges, goldenrods, and other herbs. Calcicoles such as small-flowered agrimony* were locally abundant in the open areas. Silky dogwood, eastern cottonwood, American elm, and willows comprised the shrub layer. The microtopography was complex with numerous sedge tussocks and small hollows that held standing water during early spring.

Occurrence in the Study Area

We documented a single occurrence of wet clay meadow habitat in the Fishkill portion of the study area. This meadow was less than 1 ac (0.4 ha) and located in the far southwestern end of the corridor, just west of Victoria Lane.

Conservation Considerations

We have found many plants of regional or statewide significance in wet clay meadows, such as Frank's sedge,* Bush's sedge,* buttonbush dodder,* downy ground-cherry,* small skullcap,* winged loosestrife,* and ragged fringed orchid.* The Baltimore* (butterfly) has been found in wet clay meadows, and other rare butterflies are likely if their host plants are present. Because wet clay meadows resemble oldfield and shrubland habitats, they share some of the same biodiversity values of those habitats. For example, wet clay meadows are used for courtship displays by American woodcock, and those that are part of larger meadow or shrubland complexes may support grassland breeding birds.

Wet clay meadows, like other oldfield habitats, are often subject to ATV use and similar uses that can disturb nesting birds, cause erosion, soil compaction, and soil loss, and invite invasive plant species. Purple loosestrife has taken over some wet clay meadows in the region. Mowing or brush-hogging could help to control loosestrife and maintain an open habitat, but could also harm rare plants or disturb nesting birds. Wet clay meadows are often attractive sites for residential, industrial, or commercial developments that may destroy, fragment, or otherwise degrade the meadow habitat.

ACIDIC BOG (ab)

Ecological Attributes

An acidic bog is a rare wetland habitat that is perennially wet, very nutrient poor, and dominated by shrubs of the heath family and extensive carpets or floating mats of peat moss (*Sphagnum*). Bog soils consist of deep, partially decomposed peat moss and other organic matter that isolates the bog from ground water influence. Acidic bogs, therefore, are fed primarily by precipitation and by surface runoff from the immediate watershed. The thick peat moss also helps insulate the underlying ice into late spring or early summer, thereby maintaining a cool microclimate that supports a boreal relict plant community.

The acidic bog habitat in the study area was characterized by an extensive carpet of thick S*phagnum*. Several species of sphagnum covered large hummocks throughout the bog mat; many hummocks were more than 3 ft (1m) in diameter and 1.6 ft (0.5 m) tall. Insectivorous species such as pitcher-plant and round-leaved sundew were abundant in the low-lying areas and along the bases of hummocks. Leatherleaf, small cranberry, sheep laurel, and small individuals of highbush blueberry were co-dominant species in the low shrub layer, which represented 30 - 50 percent overall cover. The tall shrub layer was generally confined to the elevated hummocks and the outer edge of the bog mat. Typical tall shrub species included swamp azalea, highbush blueberry, gray birch, and red maple. Small white pine and red maple trees formed small to mid-sized clumps throughout the bog, especially along the outer edge of the bog mat. A narrow band of hardwood and shrub swamp occurred between the acidic bog and the surrounding upland forest habitat.

A small pool within the acidic bog had a rather distinctive plant community and physical appearance. We believe this pool may be at least weakly influenced by mineral rich ground water. The pool contained a mix of shallow open water areas and exposed mud flats, all over a deep, fine silty muck substrate. Some portions of the pool were dominated by water-willow. A narrow band of high tussocks surrounded the pool, and supported several sedges, marsh fern, royal fern, cinnamon fern, pitcher-plant, and leatherleaf. Poison sumac was the dominant tall shrub in the vicinity of the pool, often forming dense thickets.

Occurrence in the Study Area

We documented a single acidic bog in the Fishkill portion of the study area. This 9 ac (3.6 ha) bog was located in the far eastern end of the corridor, just northeast of the junction of Lake Road and Route 82. Although it was surrounded by development, we considered this bog to be an ecologically significant habitat due to its rarity, large size, and high habitat quality.

Conservation Considerations

Acidic bog is a rare habitat in the Hudson Valley, and many of the characteristic species of acidic bogs are rare or uncommon in the region; for example, Virginia chain fern,* white beakrush,* cottongrasses,* pitcher-plant,* round-leaved sundew,* leatherleaf,* and cranberries.* Four-toed salamander* may occur in bogs and similar wetlands with deep mats of sphagnum and other mosses on rocks, logs, and woody hummocks. Breeding birds of acidic bogs in the region include Nashville warbler,* golden-winged warbler,* northern waterthrush,* and eastern bluebird. Southern bog lemming* could occur in bogs and adjacent forests.

Bog soils and vegetation are easily damaged by foot traffic and similar disturbance. Because bog ecology seems to depend on a cool microclimate and low nutrient availability, bogs are probably sensitive to removal of forest in surrounding areas and to nutrient pollution.

Protection of large forested buffer zones around bogs would help to maintain the water quality essential to bog ecology, and to insulate the bog community from other aspects of human disturbance.

INTERMITTENT WOODLAND POOL (iwp)

Ecological Attributes

An intermittent woodland pool is a small wetland habitat that has standing water during the winter and spring, but typically drying out by mid- to late summer. Intermittent woodland pools are surrounded partially or entirely by forest and are a subset of the "vernal pool" habitat (which may or may not be surrounded by forest). The hydroperiod, or duration of standing water, varies from year to year depending mainly on the timing and intensity of precipitation. Intermittent woodland pools have no perennial inlet or outlet stream and are generally isolated from other wetland and stream systems. Some, however, are drained by shallow intermittent streams that flow only briefly when pool water levels are at their maximum.

Despite the small size of intermittent woodland pools, those that hold water through early summer can support amphibian diversity equal to or greater than that of much larger wetlands (Semlitsch and Brodie 1998, Semlitsch 2000). The seasonal drying and isolated nature of these pools help exclude fish, which are major predators on amphibian eggs and larvae. Because of this, these pools provide critical breeding and nursery habitat for numerous salamander and frog species. The surrounding forest provides essential habitat for adult and juvenile amphibians during the non-breeding season.

Several amphibian species and at least one group of invertebrates are considered obligate intermittent woodland pool species because they are entirely dependant on the predator free conditions of this habitat to successfully complete their life cycle. Breeding activity by obligate species is frequently used as an indicator for this habitat. Tadpoles, egg masses, or individuals of wood frog, spotted salamander, and fairy shrimp were observed in a number of intermittent woodland pools in the study area during spring field visits.

Most of the intermittent woodland pools in the corridor occurred in upland hardwood forest habitat, but we mapped a few pools in drier hardwood swamps if they appeared to be suitable amphibian breeding habitat and we believed fish were absent. Most of the woodland pools had water depths of 10 - 18 in (25.4 - 45.7 cm) during our early spring visits. In some the water was strongly tea-colored.

Vegetation tends to be sparse in intermittent woodland pools, but several common species were present in most occurrences in the study area. Trees such as red maple, pin oak, and American elm grew along the edge and on large hummocks (woody root crowns) in the pool. Various shrubs such as winterberry, highbush blueberry, buttonbush, and silky dogwood were also common on these hummocks.

Occurrence in the Study Area

We documented intermittent woodland pools in all three towns of the study area. The LaGrange portion of the corridor contained a total of 31 pools, Fishkill had 29, and Beekman had 5. Most were less than 0.5 ac (0.2 ha). The biodiversity potential of these pools varied considerably throughout the corridor, some especially high quality examples occurred in the LaGrange portion of the corridor in the forested hills bordering the Taconic State Parkway north of Route 55. Several high quality woodland pools also occurred on Honness Mountain in the Fishkill portion of the corridor. All of these examples were located within large blocks of contiguous forest, and we observed breeding obligate woodland pool species in many.

Conservation Considerations

Intermittent woodland pools are an imperiled habitat in the Hudson Valley region, in part because they have been frequently overlooked in environmental reviews of proposed developments and have been drained, filled, or dumped in by landowners and developers. Even when the pools themselves are spared in a development plan, the surrounding forests so essential to the ecological functions of the pools are frequently destroyed. Intermittent woodland pools are often excluded from federal and state wetland protection due to their small size, their temporary surface water, and their isolation from other wetland habitats. It is these very characteristics of size, isolation, and intermittency however, that make woodland pools uniquely suited to species that do not reproduce or compete successfully in larger wetland or pond systems.

Intermittent pools provide critical breeding and nursery habitat for an array of rare amphibian species, including the Jefferson salamander,* marbled salamander,* spotted salamander,* and wood frog.* The spotted turtle* uses intermittent woodland pools for foraging, rehydrating, and shelter. Wood duck* and American black duck* use intermittent woodland pools for nesting, brood-rearing, and foraging. The invertebrate communities of these pools can be rich, providing abundant food for songbirds such as yellow warbler, common yellowthroat, and northern waterthrush. Springtime physa, a regionally rare snail, is also associated with intermittent woodland pools. At least two rare plants, featherfoil* and false hop sedge,* occur in intermittent woodland pools in the lower Hudson Valley.

The mole salamanders (including Jefferson, marbled, and spotted salamander) breed in intermittent woodland pools, but spend most of their juvenile and adult lives in the soils and organic litter of surrounding upland forests. These salamanders are known to migrate seasonally up to 650 ft (198 m) from their breeding pools into surrounding forests (Downs 1989, Semlitsch 1998). A wood frog juvenile may travel as far as 1,550 ft (472 m) from a breeding pool into the surrounding upland forests (Calhoun and Klemens 2002). Both salamanders and frogs are highly vulnerable to vehicle mortality where roads or driveways cross their travel routes between intermittent woodland pool and upland forest habitats. The loss of individual pools or the forested connections between them can cause local extinctions of species.

Intermittent woodland pools produce mosquitoes and are sometimes targeted with pesticides or biocontrols to kill mosquitoes. However, the mosquito believed to be most important in transmitting West Nile Virus to humans, *Culex pipiens*, does not typically breed in intermittent woodland pools unless the pools are polluted with sewage, manure, or other organic materials.

Important conservation measures for intermittent woodland pools include protecting pools from filling, draining, dumping, dredging, logging, pollution, siltation, or compaction; protecting large areas of surrounding forests; and preserving overland connections between pools. Calhoun and Klemens (2002) recommended protecting a 750 ft (228 m) forested radius around each intermittent woodland pool, an area representing the critical habitat zone for obligate pool-breeding amphibians.

KETTLE SHRUB POOL (ksp)

Ecological Attributes

A kettle shrub pool is a seasonally or permanently flooded, shrub-dominated wetland located in a glacial kettle—a depression formed by the melting of a stranded block of glacial ice. These pools are adjacent to soils formed in glacial outwash (e.g. Hoosic gravelly loam). Standing water is typically 1 - 3 ft (0.3 - 1 m) or more deep and is often stained a dark tea color. These habitats have a thick organic (muck) substrate, usually with a surface layer of undecomposed leaf litter and woody debris. Kettle shrub pools typically have no stream inlet or outlet, although some may have a small intermittent stream outlet. Often, a shrub thicket in the middle of the pool is entirely or partly surrounded by an open water moat.

Most kettle shrub pools in the study area were dominated by buttonbush, an aquatic shrub. Buttonbush often formed dense stands throughout most pools, sometimes covering 75 percent or more of the pool surface. Other kettle shrub pools contained a somewhat more diverse shrub community composed of highbush blueberry, swamp azalea, winterberry, alder, silky dogwood, pussy willow and young stems of red maple, green ash, and swamp white oak. Duckweeds, coontails, and liverworts, along with other living and dead plant material, formed floating mats on the pool surface. Cover by emergent herbaceous species was generally low or patchy, and included purple loosestrife, tussock sedge, bur-reed, beggarticks, water-plantain, and arrowhead. Trees such as red maple and American elm were sparse in the pool interior. Many pools had a ring of mature hardwoods around all or most of the perimeter.

Occurrence in the Study Area

We found kettle shrub pools in all three segments of the study area, but the LaGrange portion contained the greatest number. The 18 pools mapped in LaGrange ranged from less than 0.5 ac

(0.2 ha) to nearly 13 ac (5.2 ha). Thirteen of these were concentrated in the broad glacial outwash plain south of Route 55. The remaining pools were scattered along narrow bands or small inclusions of outwash in the northern half of the corridor. We considered all of these shrub pools to have high ecological value due to their habitat structure and (for most) proximity to one another.

Just two kettle shrub pools were mapped in the Fishkill portion of the corridor. Both were small (< 1 ac [0.4 ha]) and located in an intensively developed area west of the Route 9 - Interstate 84 interchange. The habitat value of these pools was lower due to the disturbed condition of the surrounding landscape.

The Beekman portion of the corridor had only one kettle shrub pool. This 6.3 ac (2.5 ha) pool was located just north of Sylvan Lake Road in an area of mixed land use. Although the habitat structure was quite good, its overall habitat value may be diminished by the apparent isolation of this pool from other kettle shrub pools.

Conservation Considerations

A kettle shrub pool or similar wetland is an essential part of the core habitat of the threatened Blanding's turtle.* The Blanding's turtle uses kettle shrub pools during two crucial phases of its life cycle, winter hibernation and spring basking. In late spring and early summer, adult females move overland to upland nesting sites, and, during the spring and summer, adult males and females use kettle shrub pools and a variety of other wetlands for foraging, resting, and drought refuge.

Most Blanding's turtle seasonal movements occur within a 3,300 ft (1,000 m) radius of their winter and spring wetland habitat. In the Northeast and elsewhere in their range, however, movements of 6,500 feet (2,000 m) or more have been documented on numerous occasions (Joyal et al. 2000, Fowle 2001, Joyal et al. 2001). To delineate the potential extent of the habitat complex used by a Blanding's turtle population, we draw a 1,000 m and a 2,000 m radius around their winter and spring wetland habitat (i.e. kettle shrub pools). We consider 1,000 m to be the zone of primary concern, and 2,000 m to be the zone of secondary concern

(Hartwig et al. in prep). The 1000 m zone encompasses the wetlands that the turtles use regularly, most of the nesting areas, and most of the travel corridors. One can expect turtles regularly in this zone throughout the active season (April through October). The 2000 m zone encompasses the landscape within which the Blanding's turtle travels to explore new wetlands, and sometimes to nest. One can expect a few turtles from a particular core wetland in this zone each year. Within these zones, potential Blanding's turtle habitats include both wetlands and upland nesting habitats, as well as the travel corridors between them. Nesting habitats are typically non-forested, unshaded habitats with loose, coarse-textured, well drained soil (often gardens, agricultural fields, utility rights-of-way, soil mines, etc.).

At least two state-listed rare plants (spiny coontail* and buttonbush dodder*) and three regionally-rare plants (the moss *Helodium paludosum**, short-awn foxtail*, and pale alkali-grass*) have been found in kettle shrub pools. Kettle shrub pools are used by spotted turtle*, wood duck*, mallard, American black duck,* and many other wildlife species.

By identifying kettle shrub pools, we have identified some of the key winter and spring habitats that may be used by Blanding's turtles in normal years. Proposed development near a Blanding's turtle habitat complex, especially within the 1,000 m zone of primary concern, should be carefully planned and executed to prevent loss or degradation of wetlands, and to maintain important travelways between wetlands and upland nesting habitats.

OPEN WATER (ow)

Ecological Attributes

Open water habitats include natural ponds and lakes, large open water areas within marshes, and ponds that may have originally been constructed but have since reverted to a more natural state (e.g. surrounded by unmanaged vegetation; no longer maintained as ornamental or livestock ponds, etc.). Most of the open water habitats in the study area appeared to be constructed ponds (see below) that are no longer managed and have been allowed to revert to a more natural condition. Open water habitats were usually buffered from developed areas by a ring of natural upland vegetation. The interior of these habitats was often free of vegetation, but in a few cases submerged and floating leaved aquatic vegetation such as duckweed, coontail, and yellow water-crowfoot formed a thin mat at the water surface.

Occurrence in the Study Area

Natural open water was an uncommon habitat type in the study area, although all three sections of the corridor contained at least a few occurrences. The Fishkill portion of the corridor had a total of 8 open water areas, most of which were smaller than 1 ac (0.4 ha). We documented a total of 7 open water ponds in the Beekman portion of the study area, including one that was nearly 3 ac (1.2 ha). The LaGrange portion of the corridor had only two of these habitats; both were 0.5 ac (0.2 ha) or less.

Conservation Considerations

Open water habitats are used by many common species of invertebrates, fishes, frogs, turtles, waterfowl, and mammals. American bittern,* osprey,* bald eagle,* and great blue heron* may use open water areas as foraging habitat. Blanding's turtle* and spotted turtle* use ponds and lakes during non-drought periods and as refuges during drought periods. Wood turtle* may overwinter and mate in open water areas. Northern cricket frog* may occur in circumneutral ponds, and spiny coontail* is known from several calcareous open water ponds. Open water areas sometimes support submerged aquatic vegetation that can provide important habitat for aquatic invertebrates and fish.

The habitat value of natural open water areas can be greater than that of constructed ponds if they are less intensively managed, less disturbed by human activities, and located within a mosaic of undeveloped habitat. These habitats are, however, vulnerable to human impacts, such as use of motorized watercraft, shoreline development, aquatic weed control, and runoff from roads, lawns, and agricultural areas. Aquatic weed control, which may include use of herbicides, grass carp, harvesting, and biocontrol, is an especially important concern in open water habitats, and the potential negative impacts should be assessed carefully before any such activities are undertaken. To protect water quality and habitat values, broad zones of undisturbed vegetation and soils should be maintained around undeveloped ponds and lakes. If part of a pond or lake must be kept open for ornamental or other reasons, it is desirable to avoid dredging and to allow other parts of the pond to develop abundant vegetation.

CONSTRUCTED POND (cp)

Ecological Attributes

Constructed ponds include water bodies that have been excavated or dammed by humans, either in existing wetlands or in upland terrain, for such purposes as aesthetics, recreation, watering livestock, irrigation, or drinking water (e.g. reservoirs). They also include water bodies created during mining operations. Most of these habitats are intensively managed (e.g. shoreline mowing, herbicide application) or subject to disturbance from the surrounding landscape (e.g. contaminated runoff from agriculture and private yards) and lack of natural vegetated buffers. If left unmanaged, however, constructed ponds often revert to open water or wetland habitat with a much higher habitat value.

Occurrence in the Study Area

We mapped a total of 160 constructed ponds in the study area. Most of these ponds were smaller than 1 ac (0.4 ha). The LaGrange portion of the study area had 90. The largest (nearly 17 ac [6.9 ha]) was in an active gravel mine just north of Velie Road. This pond was not seen in its entirety and may be considerably larger than mapped.

We documented a total of 36 constructed ponds in the Beekman portion of the corridor, with the largest (53 ac [21.5 ha]) located in a recently abandoned gravel mine along Green Haven Road. We also mapped two mid-sized sewage treatment ponds on the Green Haven Prison property as “constructed pond.”

The Fishkill portion of the study area contained a total of 35 constructed ponds. The largest of these (9.5 ac [3.8 ha]) was part of a stormwater detention basin system in a development just west of Route 9. Many of the constructed ponds in the Fishkill Creek corridor were located within landscaped areas near residences and other developments. Some, however, were associated with active or recently abandoned agricultural lands—especially in the Beekman portion of the corridor.

Conservation Considerations

The habitat values of constructed ponds vary depending on the landscape context and the extent of human disturbance. If constructed ponds are not intensively disturbed by human activities, they can be important habitats for many of the common and rare species that are associated with natural open water habitats (see above). In general, the habitat value increases when the ponds have undeveloped shorelines, are relatively undisturbed by human activities, and are embedded within a mosaic of intact habitat. Because many constructed ponds are not buffered by natural vegetation, they are vulnerable to the adverse impacts of agricultural runoff, septic leachate, and pesticide/fertilizer runoff from lawns and gardens. We expect that many of those maintained as ornamental ponds are treated with herbicides and perhaps other toxins. Since constructed ponds serve as potential habitat for a variety of common and rare species, care should be taken to minimize these impacts.

The habitat values of constructed ponds, especially intensively managed ornamental ponds, do not ordinarily justify altering streams or destroying natural wetland or upland habitats to create those ponds. In most cases, the loss of ecological functions of natural habitats far outweighs any habitat value gained in the new artificial environments.

SPRINGS & SEEPS

Ecological Attributes

Springs and seeps are places where groundwater discharges to the ground surface, either at a single point (a spring) or diffusely (a seep). Although springs often discharge into ponds, streams, or wetlands such as fens, we mapped only springs and seeps that discharged conspicuously into upland locations. These aquatic features often emerge at the base of a ledge or slope, or just upgradient of a wetland or stream. Springs and seeps originating from deep groundwater sources flow more or less continuously while those from shallower sources flow intermittently. Because groundwater discharge in our region has a fairly constant temperature of about 50-55^{o} F (10-13^{o} C), springs and seeps are warmer than their surroundings in winter and cooler in summer. The habitats created at springs and seeps are determined in part by the hydroperiod and the chemistry of the soils and bedrock through which the groundwater flows before emerging. In the study area, a few seeps with calcareous groundwater discharge supported yellow sedge, shrubby cinquefoil, and other calcicoles.

Occurrence in the Study Area

We observed springs and seeps in all three portions of the study area. The Fishkill portion had at least 25 individual occurrences of springs and seeps; most were located at various points along the base of Fishkill Ridge and Honness Mountain. One hillside just north of Mountain Lane contained so many seeps that instead of mapping them individually, we used a polygon overlay to map this 16 ac (6.5 ha) seep complex. We observed far fewer springs and seeps in the Beekman and LaGrange portions of the corridor, which had 3 and 2 occurrences respectively. Because the occurrence of springs and seeps is difficult to predict by remote sensing, we mapped only the very few we happened to see in the field. We expect there are many more springs and seeps in the study area that we did not map. More detailed inventories of springs and seeps should be conducted as needed on a site-by-site basis.

Conservation Considerations

Very little is known, or at least published, on the ecology of seeps in the Northeast. Springs and seeps provide important water sources for many organisms during droughts, and during winter when some of these habitats may remain free of ice. Because springs and seeps tend to be warmer than surrounding habitats in winter and cooler than surrounding habitats in summer, they sometimes support certain organisms that occur rarely or not at all in other habitats in the region. Golden saxifrage is a plant restricted to springs and groundwater-fed streams and wetlands. A few rare invertebrates are restricted to springs in the region; for example, gray petaltail* and tiger spiketail* are two rare dragonflies of seeps. Springs emanating from calcareous bedrock or calcium-rich surficial deposits sometimes support an abundant and diverse snail fauna. Northern dusky salamander* and northern two-lined salamander are typically associated with springs and cold streams.

Springs are easily disrupted by disturbance to upgradient land or groundwater, altered patterns of surface water infiltration, or pollution of infiltering waters. Many springs have been modified for water supply, and some have had spring houses constructed over excavated basins. In many areas, groundwater has been polluted, or drawn-down by pumping for human or livestock water supply, affecting the quality or quantity of water issuing from seeps and springs.

PERENNIAL & INTERMITTENT STREAMS

Ecological Attributes

Perennial streams flow continuously during years with normal precipitation, but some smaller perennial streams may dry up during droughts. Intermittent streams flow only during certain times of year or after rains and snowmelt. They are the headwaters of many perennial streams, and are significant water sources for lakes, ponds, and wetlands of all kinds. The condition of intermittent streams therefore influences the water quality and quantity of those larger water bodies and wetlands. Factors such as underlying and nearby geology and land uses in the watershed have a strong influence on the physical, chemical, and biological character of these aquatic systems, including the type of the substrate (e.g. clay, sand, gravel, cobbles, or bedrock), water quality, and the composition of plant and animal communities.

We mapped larger low-gradient streams, such as Fishkill Creek and Sprout Creek, and the numerous smaller perennial and intermittent streams found throughout the landscape as a single habitat type. We did distinguish between perennial and intermittent streams, however, in the accompanying GIS attribute table for this habitat. The habitat structure and quality of these streams varied considerably depending on the type and intensity of the surrounding land use and the local environmental conditions. Portions of streams influenced by tidal water from the Hudson River were mapped as a separate habitat type.

Occurrence in the Study Area

Perennial streams were distributed throughout the Beekman, LaGrange, and Fishkill portions of the study area, while intermittent streams were most common in the hilly terrain. We expect that there are additional intermittent streams that we have missed.

Conservation Considerations

Streams and their associated riparian zones tend to have high species diversity and high biological productivity. Most fish and wildlife depend upon riparian habitats in some way for their survival (Hubbard 1977, McCormick 1978). Perennial streams and riparian zones provide nesting and foraging habitat for many species of birds, such as spotted sandpiper, belted kingfisher, tree swallow, bank swallow, Louisiana waterthrush, great blue heron* and green heron. Red-shouldered hawk,* willow flycatcher, prothonotary warbler, and cerulean warbler* nest in areas with extensive riparian forests, especially those with mature trees. Bats use perennial stream corridors for foraging. Wood turtle* uses perennial streams with pools and recumbent logs, undercut banks, and muskrat or beaver burrows. The fish and aquatic invertebrate communities of perennial streams may be diverse, especially in clean-water streams with unsilted bottoms. Brook trout* and slimy sculpin* are two native fish species that require clear, cool streams for successful spawning and nursery habitats. Wild brook trout, however, are now confined largely to small headwater streams in the region, due to degraded water quality and competition from brown trout, a non-native species stocked by the state and by private groups. Muskrat, beaver, mink, and river otter,* are some of the mammals that use riparian corridors regularly. We know of many rare plants of riparian zones, such as cattail sedge,* Davis' sedge,* and diarrhena* (a grass).

Intermittent streams can be important local water sources for wildlife, and their disappearance in a portion of the landscape can affect the presence and behavior of wildlife populations over a large area. Although intermittent streams have been little studied by biologists, they have nonetheless been found to support rich aquatic invertebrate communities, including regionally rare and state-listed rare mollusks (Gremaud 1977) and dragonflies. Both perennial and intermittent streams provide breeding, larval, and adult habitat for northern dusky salamander,* and northern two-lined salamander. The forests and sometimes the meadows adjacent to streams provide foraging habitats for adults and juveniles of these species.

Removal of trees or other shade-producing vegetation along streams can lead to elevated stream temperatures that can adversely affect aquatic invertebrate and fish communities. Clearing of floodplain vegetation can reduce the important exchange of nutrients and organic materials between the stream and the floodplain, and can diminish the floodplain's capacity for floodwater attenuation, leading to increased flooding downstream, scouring and bank erosion, and sedimentation of downstream reaches. Any alteration of flooding regimes, stream water volumes, timing of runoff, and water quality can profoundly affect the habitats and species of streams and riparian zones. Hardening of the streambanks with concrete, riprap, gabions, or other materials reduces the biological and physical interactions between the stream and floodplain, and tends to be harmful both to stream and floodplain habitats. Removal of snags from the streambed degrades habitat for fishes, turtles, snakes, birds, muskrats, and their food organisms.

Effective protection of stream habitats, therefore, requires attention not only to the stream channel, but to land uses in the riparian corridor and throughout the watershed. Applications of fertilizers and pesticides to agricultural fields, golf courses, lawns, and gardens in or near the riparian zone can degrade the water quality and alter the biological communities of streams. Construction, paving, logging, soil mining, clearing of vistas, creating lawns, and other disruptive activities in and near riparian zones can eliminate riparian functions and adversely affect the species that depend on streams, riparian zones, and nearby upland habitats. Because one of the most important means of protecting stream quality is to protect the riparian zones from disturbance, we recommend maintaining (or restoring, if necessary) natural riparian habitats wherever possible. Activities in the watershed that cause soil erosion, increased surface water runoff, reduced groundwater infiltration, or contamination of surface water or groundwater are likely to affect stream habitats adversely. For example, an increase in impervious surfaces (roads, parking lots, roofs) may elevate runoff volumes, leading to erosion of stream banks and siltation of stream bottoms and degrading the habitat for invertebrates, fish, and other animals. Road runoff often carries contaminants such as petroleum hydrocarbons, heavy metals, road salt, sand, and silt into streams.

TIDAL and SUPRATIDAL HABITATS

ESTUARINE ROCKY SHORE (ers)

Ecological Attributes

This habitat type includes beaches of gravel, cobble, and natural rock rubble, as well as rock outcrops, ledges, and cliffs in and above the intertidal zone of the Hudson River. Estuarine rocky shores are subjected to regular tidal inundation or wetting by wave splash and wind spray. These habitats also experience rapid heating and cooling, ice scouring in winter, and intermittent wind and wave disturbance. The plant community is usually sparse in the intertidal zone, but may be moderately dense in the splash zone above the high water mark. In the study area, most estuarine rocky shores were narrow beaches of unconsolidated gravel and cobble with small patches of mid-sized rock material. No intertidal rock outcrops, ledges, or cliffs were observed within the study area.

Occurrence in the Study Area

We documented estuarine rocky shore only in the Town of Fishkill and the City of Beacon. About 5,164 linear feet (1,574 linear meters) of rocky shore habitat was observed in various locations along the eastern bank of the Hudson River and the west shore of Denning Point. Except for a few remote areas, much of this habitat was disturbed by human activity (e.g. fishing, garbage).

Conservation Considerations

We know little about the ecology of rocky shore environments on the Hudson River. Rare plants of the upper intertidal zone of freshwater reaches of the Hudson include estuary beggar-ticks,* heartleaf plantain,* and terrestrial starwort.* Eastern prickly-pear* has been found on a rocky shore in Rockland County, and river birch* on a rocky peninsula in Dutchess County. Northern white cedar* occurs on cliffs and rocky shores in Dutchess and Columbia counties. Map turtle* basks and nests on Hudson River rocky shores, and harbor seal* sometimes hauls

out onto rocky shores in locations isolated from human activities. Mallard and American black duck* are known to nest on rocks above the mean high water elevation.
The biological communities of Hudson River rocky shores seem to be well-adapted to disturbances caused by wind, waves, and ice, but can be damaged or destroyed by excessive human foot traffic or by use of wheeled or tracked vehicles. Human intrusions are likely to discourage use of rocky shore sites by nesting waterfowl or by harbor seals. For these reasons, developed features including walking trails should be located away from these and other shoreline habitats wherever possible.

SUPRATIDAL RAILROAD CAUSEWAY (src)

We use the term supratidal railroad causeway to describe the elevated railroad tracks that run along the shores of the Hudson River. These railroads rest on a foundation of fill material composed of coal cinder and crushed stone over larger blocks of rock. The railroad beds are contaminated with toxic elements and organic compounds from coal and petroleum use, and are repeatedly sprayed with herbicides to prevent vegetation from overgrowing the tracks. Discarded railroad ties and a variety of other railroad-generated refuse litter large areas of the habitat. The vegetation is typically dominated by non-native species and can range from nearly bare to a moderate cover of herbs and grasses. A narrow band of shrubs and young trees often occurs along the base of the railroad bed. A supratidal railroad causeway runs along the eastern shore of the Hudson River in the Fishkill portion of the study area.

Despite its highly disturbed nature, this habitat does have some potential biodiversity value worth noting. Several rare plants, including Drummond's rock-cress,* slender knotweed,* and kidneyleaf mud-plantain,* are known from supratidal railroads in the Hudson Valley. These railroads are also used intensively for nesting by snapping and eastern painted turtles. Wood turtle* and spotted turtle* may also use the cinders and exposed gravel found along the railroad for nesting, and this habitat is sometimes used by snakes for basking.

TIDAL TRIBUTARY MOUTH (ttm)

Ecological Attributes

The term "tidal tributary mouth" refers to the tidal reaches of Hudson River tributary streams. This habitat occurs no higher (farther upstream) than the first topographic contour line (10-20 ft [3-6 m] elevation) or the first dam, whichever is lower. This portion of the stream is strongly influenced by the mixing of nontidal and tidal waters. The substrate and water chemistry of these habitats are often very different from those found in the adjoining tributary or in the Hudson River. Salinity values can fluctuate considerably depending on the season, stream volume and the tide. In winter there is often intense ice scouring of the stream bed and shore line. The plant and animal communities are composed mainly of freshwater species able to tolerate tidal fluctuations and seasonally brackish waters.

The tidal mouth habitat of Fishkill Creek had a fine sand and mucky silt substrate with a moderate cover of submerged aquatic vegetation dominated by non-native species such as water chestnut, Eurasian water milfoil, and curly pondweed. A smaller portion of this habitat near the upstream limit of tidal influence had a small to mid-sized rock, gravel, and coarse sand substrate with little aquatic vegetation.

Occurrence in the Study Area

The only occurrence of tidal tributary mouth habitat in the study area was at the mouth of Fishkill Creek in the City of Beacon. We considered the dam just east of South Avenue (approximately 3280 ft [1000 m] upstream from the Hudson River) to be the upper limit of tidal influence and thus the upper limit of this habitat. The lower reach of the tidal tributary mouth split into two separate stream channels with a broad expanse of high quality intertidal marsh and mudflat between.

Conservation Considerations

Tidal tributary mouths tend to be sites of concentrated biological activity. Macroinvertebrates may be abundant and diverse in these habitats, which also serve as spawning sites for fishes, and foraging sites for wading birds, waterfowl, and raptors. Several rare or uncommon plants such as lizard's tail,* estuary beggar-ticks,* smooth bur-marigold,* and goldenclub,* and at least one rare snail, *Pomatiopsis lapidaria*, have been found in tidal tributary mouths of the Hudson.

Noise, pollution, and mechanical disturbance from boat traffic can cause extreme disturbance to the plant and animal communities of tidal tributary mouths. Foot traffic on tributary banks can damage vegetation and increase susceptibility to bank erosion. Poor water quality in the tributary streams will reduce the habitat quality of the tidal stream mouths. Dams impede fish spawning runs, and the installation of fish ladders or dam by-passes would do much to support the populations of river herring (alewife & blueback herring) and many other fish species that spawn in non-tidal portions of Hudson River tributaries.

INTERTIDAL MARSH (im)

Ecological Attributes

An intertidal marsh is a non-forested wetland that occurs in the shallow bays and tributary mouths along the tidal portion of the Hudson River, in the elevation zone between mean high water and mean low water. The substrate is regularly exposed at low tide and flooded twice daily by high tide. In the study area, the tidal water can vary in salinity from fresh to slightly brackish, and is usually less than 6 ft (2 m) deep at high tide. Intertidal marshes at tributary mouths also receive water and sediment from the associated freshwater stream. The plant community is composed of emergent herbaceous species, including common freshwater marsh plants and other species tolerant of tidal fluctuations and brackish water. Low elevation areas bordering mudflats (see below) or open water are usually dominated by low broad-leaf emergents and submerged aquatics. More elevated portions of the marsh are frequently dominated by tall, narrow-leaf emergents.

This zonation of the plant community was observed in many intertidal marshes in the study area, especially in the larger marshes. The low elevation zones were dominated by spatterdock, arrow arum, pickerelweed, strap-leaf arrowhead, and broadleaf arrowhead. Narrow-leaf cattail, sweetflag, and blue flag formed dense stands in the higher elevation zones. Invasive species such as common reed and purple loosestrife were sparse or confined to small patches. Eurasian watermilfoil and water chestnut (two non-native aquatics) were extensive in the deepest intertidal areas.

Occurrence in the Study Area

Intertidal marsh was confined to the Fishkill Creek mouth and associated bay in the Fishkill portion of the study area. We mapped a total of 15.5 ac (6.3 ha) of intertidal marsh, with individual occurrences ranging from less than 1 ac (0.4 ha) to 13 ac (5.3 ha). We consider all of these marshes to be ecologically significant, but the largest marsh was particularly noteworthy due to its size, complex habitat structure, dominance by native species, and high biodiversity potential.

Conservation Considerations

The fishes and birds of freshwater and brackish tidal marshes can be diverse and abundant. Least bittern,* American bittern,* sora, Virginia rail, and common moorhen* are known to breed in Hudson River tidal marshes, and osprey and northern harrier forage in these habitats. Many rare plants have been reported from these habitats, including Fernald's sedge,* Long's bittercress,* spongy arrowhead,* goldenclub,* American waterwort,* and heartleaf plantain.*

Soil compaction and trampling or clearing of vegetation in tidal marshes can damage microhabitats and can promote the spread of invasive plants such as common reed or purple loosestrife. Motorized boat traffic can cause water pollution and mechanical destruction of plants, and can disturb breeding and foraging birds and other animals of these habitats. Any alteration of wave stresses or deposition regimes could alter the extent or quality of the tidal marsh habitats at the mouth of Fishkill Creek.

INTERTIDAL MUDFLAT (imf)

Ecological Attributes

An intertidal mudflat is a sparsely vegetated wetland that occurs in the shallow bays, tributary mouths, and other shallow zones in the tidal portion of the Hudson River. These habitats are restricted to the lowest portion of the intertidal zone, usually between intertidal marsh and permanent open water. Intertidal mudflats experience the deepest flooding at high tide and are exposed for the shortest period of time at low tide. The sparse plant community typically is low-growing, rosette-leaved aquatics that are completely submerged at high tide.

In the study area, greater than 75 percent of the mudflat was bare at low tide during late spring visits. Species such as strap-leaf arrowhead, arrowhead, and tapegrass were sparse or occurred in small patches across the mudflats.

Occurrence in the Study Area

We documented intertidal mudflat only in the mouth of Fishkill Creek in the Town of Fishkill and the City of Beacon. Six high quality mudflat areas totaled 7.5 ac (3 ha), with individual occurrences ranging from less than 1 ac to 2.5 ac (<0.4 - 1 ha).

Conservation Considerations

Wading birds, waterfowl, and raptors forage on mudflats at lower tide levels. Some rare plants of Hudson River tidal mudflats include strapleaf arrowhead,* spongy arrowhead,* mudwort,* and false-pimpernel.* These habitats are sensitive to the same kinds of mechanical, pollution, and noise disturbances described for tidal marshes. Any alteration of wave stresses or deposition regimes could alter the extent or quality of the mudflat habitats at the mouth of Fishkill Creek.

INTERTIDAL SWAMP (is)

Ecological Attributes

Intertidal swamp is a forested or shrub-dominated wetland that occurs in the upper intertidal zone of the Hudson River, along the mainland, on islands, or in the elevated portions of intertidal marshes. Intertidal swamps may grade gently into supratidal or non-tidal hardwood and shrub swamps. The substrate is continuously wet and is subjected to twice daily flooding by tidal water, which in the study area can vary from fresh to slightly brackish. The plant community is similar to that of non-tidal swamps in the region. Areas that are more strongly influenced by the tide may have many dead or damaged trees.

Intertidal swamps in the study area were dominated by eastern cottonwood, American elm, and red maple. The shrub layer ranged from sparse to very dense and included silky dogwood, alder, willows, northern arrowwood, and multiflora rose. Sensitive fern was a common component of the herbaceous layer.

Occurrence in the Study Area

We mapped three areas of intertidal swamp near the mouth of Fishkill Creek totaling less than 3 ac (1 ha), and located at the fringes of intertidal marsh.

Conservation Considerations

Hudson River tidal swamps are biologically rich, but their ecology has been little studied. Nine species of rare mosses and two rare liverworts have been found in Dutchess County tidal swamps. Swamp lousewort,* Fernald's sedge,* and winged monkey-flower occur in several tidal swamps in the region, and goldenclub* and heartleaf plantain* have been found at swamp edges. Wood turtle,* beaver, mink, and river otter* are known to use Hudson River tidal swamps, and osprey and bald eagle sometimes perch in large trees near swamp edges.

Tidal swamps should be protected from logging and other activities that would destroy important wildlife habitat or damage the swamp floor. As with other tidal habitats, alterations to wave stresses, tidal unundation patterns, or deposition regimes could alter the extent or quality of the swamp habitats at the mouth of Fishkill Creek.

PLANNING FOR BIODIVERSITY

Goldenclub
(K. Schmidt © 2001)

Overview

Most local land use decisions in the Hudson Valley are made on a site-by-site basis without the benefit of good ecological information about the site or the surrounding lands. Al-though the incremental loss of biological resources from any single development site may seem trivial, the cumulative impacts of site-by-site decision making have included the disappearance of certain habitats from whole segments of the landscape, the fragmentation and degradation of many other habitats, the local extinction of species, and the depletion of overall biodiversity in the region.

The size of habitats, the degree of connectivity between habitats, and the juxtaposition of habitats in the landscape all have important implications for regional biodiversity. While some species and habitats may be adequately protected at a relatively small scale, many wide-ranging species with large spatial requirements, such as black bear, barred owl, and red-shouldered hawk require large, interconnected blocks of unbroken habitat. Many species, such as Blanding's turtle, timber rattlesnake, and Jefferson salamander, need to travel among different habitats to satisfy their basic needs for food, water, cover, nesting and nursery areas, and population dispersal. Landscapes that are fragmented by roads, railroads, utility corridors, and developed land limit the movements of and interactions between animals, and can disrupt patterns of dispersal, reproduction, competition, and predation. According to Wilcove et al. (1986), habitat fragmentation may be "the principal threat to most species in the temperate zone." Habitat patches surrounded by human development function as islands, and species unable to move between habitats are vulnerable to genetic isolation and local extirpation over the long term (Davies et al. 2001). Landscapes with larger areas of unfragmented habitat, on the other hand, are more likely to support a broad diversity of native species and the ecological processes and disturbance regimes that maintain those habitats and species.

Because habitats, biological communities, and ecosystems extend beyond property boundaries, the best approach to biodiversity conservation is from the perspective of whole landscapes.

The habitat maps for the study area facilitate this approach by illustrating the location and configuration of ecologically significant habitats throughout the Fishkill Creek and Sprout Creek corridors. This spatial ecological information together with the information included in this report can be applied directly to land use and conservation planning and decision-making at multiple scales:

1. *Large-scale conservation and land use planning*

   The three habitat maps and this report are practical tools that can help the towns establish conservation goals, priorities, and strategies. The maps provide a landscape perspective on the Fishkill Creek and Sprout Creek corridors that can help users prioritize areas for protection and identify sites for new development where the ecological impact will be minimized. The landscape approach is much more likely to yield sound conservation decisions than the typical parcel-by-parcel approach.

2. *Reviewing development proposals and other land use proposals*

   The habitat maps and this report can help landowners, developers, and town officials understand the ecologically significant habitats on a site and the ecological connections between habitats when considering development proposals. With this information, new developments can be sited and designed to minimize impacts to important habitats.

In the following pages, we outline recommendations for: 1) developing general conservation strategies at the landscape level; and 2) using the maps as a resource for reviewing site-specific land use proposals. In the next section, we suggest specific conservation goals and priorities for each of the three towns within the study area.

General Strategies for Biodiversity Conservation

A variety of regulatory and non-regulatory means can be employed by a municipality to achieve its conservation goals, including volunteer conservation efforts, master planning, zoning ordinances, tax incentives, land stewardship incentives, permit conditions, land acquisition, and conservation easements. Section 4 in the *Biodiversity Assessment Manual* (Kiviat and Stevens 2001) provides additional information about these and other conservation tools. Several recent publications of the Metropolitan Conservation Alliance, the Pace University Land Use Law Center, and the Environmental Law Institute describe some of the tools and techniques available to municipalities for conservation planning. *Conservation Thresholds for Land-Use Planners* (Environmental Law Institute 2003), for example, synthesizes information from the scientific literature to provide guidance to land use planners interested in establishing regulatory setbacks from sensitive habitats. A recent publication from the Metropolitan Conservation Alliance (2002) offers guidance for delineating a conservation overlay district that can be integrated into a municipal master plan and zoning ordinance.

In addition to establishing regulations and incentives designed to protect specific types of habitat, the three towns can also apply some general practices on a town-wide basis to foster biodiversity conservation. The list below is adapted from the *Biodiversity Assessment Manual* (Kiviat and Stevens 2001).

- Protect large, contiguous, unaltered tracts wherever possible.
- Preserve links, and create new links, between natural habitats on adjacent properties.
- Preserve natural disturbance processes, such as fires, floods, seasonal drawdowns, landslides, and wind exposures wherever possible.
- Restore and maintain broad buffer zones of natural vegetation along streams, along shores of other water bodies and wetlands, and around the perimeters of other sensitive habitats.
- Direct human uses toward the least sensitive areas, and minimize alteration of natural features, including vegetation, soils, bedrock, and waterways.

- Encourage development of altered land instead of unaltered land. Promote redevelopment of brownfields and previously altered sites, "infill" development, and re-use of existing structures wherever possible.
- Encourage and provide incentives for developers to consider environmental concerns early in the planning process, and incorporate biodiversity conservation principles into their choice of development sites, their site design, and their construction practices.
- Concentrate development along existing roads; discourage construction of new roads in undeveloped areas. Promote clustered and pedestrian-centered development wherever possible to maximize extent of unaltered land and minimize expanded vehicle use.
- Minimize the area of impervious surfaces (roads, parking lots, sidewalks, driveways, roof surfaces) and maximize onsite runoff retention and infiltration to help protect groundwater recharge and surface water quality and flows.
- Preserve farmland potential wherever possible.
- Plan landscapes with the broadest possible connections between open space patches. When considering protection for a particular species or group of species, design the open space networks according to the particular needs of the species of concern.
- Restore degraded habitats wherever possible, but do not use restoration projects as a license to destroy existing habitats.

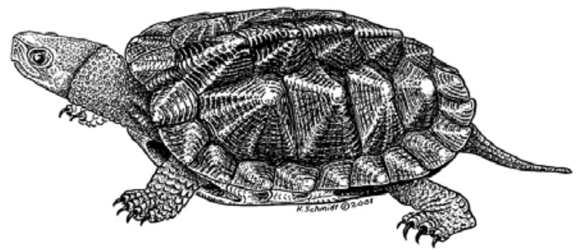
Using the Habitat Maps to Review Site-Specific Land Use Proposals

In addition to corridor-wide land use and conservation planning, the habitat maps and report can also be used for reviewing site-specific development and other land use proposals. The habitat map provides ecological information about a proposed development site, as well as a portion of the surrounding areas that might be affected, and thus can help planning and regulatory agencies consider the ecological relationships among habitats when making land use decisions. We recommend that reviewers take the following steps when considering the impact of the proposed land use change on the habitats on and near the site:

1. Consult the habitat map to see which ecologically significant habitats, if any, are located on and near the site in question.
2. Read the habitat descriptions in this report, and note the conservation recommendations for each.
3. Consider whether the proposed development project can be designed or modified to ensure that the habitats of greatest ecological concern, as well as the ecological connections between them, are maintained intact. Design modifications may include (but are not limited to):
   - Minimizing intrusions into large forest or meadow habitats.
   - Minimizing intrusions into forested areas that are within 750 ft (230 m) of an intermittent woodland pool.
   - Avoiding disturbances that would disrupt the groundwater quantity or quality available to onsite or offsite fens and other wetlands.
   - Channeling stormwater runoff from paved areas or fertilized turf into detention basins instead of directly into streams, ponds, or wetlands.
   - Locating human activity areas as far as possible from the most sensitive habitats.
   - Locating developed features such that the broadest possible corridors of undeveloped land are maintained between habitats.

Because the habitat maps have not been 100 percent ground-truthed, we emphasize that they be used strictly as a general guide for land use planning and decision making. Onsite delineations and assessments by qualified professionals should be an integral part of the review process for any proposed land use change.

CONSERVATION PRIORITIES AND RECOMMENDATIONS



Wood turtle
(K. Schmidt © 2001)

Overview

Habitat loss and fragmentation caused by roads and developed land uses have severely strained biological resources in southern Dutchess County. There are, however, still areas of undeveloped land in the study area that contain high quality examples of significant habitats. By employing a proactive approach to land use and conservation planning, the towns of Beekman, LaGrange, and Fishkill have the opportunity to protect the integrity of their remaining biological resources for the long term.

With limited financial resources to devote to conservation purposes, local government agencies must decide how best to direct those resources to achieve the greatest conservation results. While it may be impossible to protect all significant habitats, there are reasonable ways to prioritize conservation efforts using the best available scientific information. Below we highlight some areas that we consider “priority conservation zones.” While we hope this information will help the towns think strategically about future land-use planning, this is not an exhaustive list of important conservation areas. Furthermore, our assessment of habitat quality and conservation priority is inherently limited by our lack of information from outside the corridor. Habitats not considered to be a conservation priority within the Fishkill and Sprout creek corridors may in fact be important in the context of the larger landscape. (To expand the biodiversity information for local planning, we encourage users to consult Hudsonia’s East Fishkill map and report [Stevens and Broadbent 2002] and Blanding’s turtle habitat maps and report [Hartwig et al., in prep] for six southwestern Dutchess County towns.) The priority zones outlined below should be reviewed and revised periodically to accommodate landscape changes and additional ecological information.

Delineation of Priority Conservation Zones

We used the requirements of a selected group of species to help identify some of the areas where conservation efforts might yield the greatest return for biological diversity. We chose several species or groups of species that have large home ranges, specialized habitat needs, or acute sensitivity to disturbance. Many of these are rare or declining in the region or statewide.

Localized conservation efforts that focus on protecting individual habitat units but ignore essential interactions with surrounding areas often fail to protect either the habitats themselves or the species of concern. Many habitats and species depend on regular physical or biological exchange with the larger landscape, and certain mobile and wide-ranging species require extensive habitat complexes to meet their basic needs. For these reasons, we focused on the larger landscape to safeguard the long-term viability of species and habitats of conservation concern. We have designed priority conservation areas that encompass the habitat needs of particular rare and vulnerable species, and that provide a "protective umbrella" for an array of other rare and common species that co-occur in the same habitats.

We selected species of concern (see Table 3) that are known to occur in or near the study area. Each of these species or groups requires a particular habitat type for a crucial stage in its life cycle (e.g. hibernation, breeding). These "special habitats" (see Table 3) typically form the hub of the animal's habitat complex. The various other habitats required during other life cycle stages are typically located within a specified distance of the core habitat. This distance defines the extent of the species' habitat complex and, therefore, the minimum area that needs to be protected or managed in order to conserve the species. We refer to this area as the "priority conservation zone." In most cases, the extent of the priority conservation zone corresponds to the typical distance traveled by an animal from its "special habitat" to the outer edge of its habitat complex. In the case of breeding birds of marshes, the priority zone represents a protective buffer from human activity. We utilized home-range and average travel distance data reported in the scientific literature to estimate the priority conservation zone widths for the species of concern. The results of this assessment are presented in Table 3.

We also identified several other priority conservation zones associated with highly sensitive habitats (e.g. streams, acidic bog) that are of great importance to regional biodiversity. All of these special habitats are vulnerable to disturbance from human activity and some, such as the acidic bog, are also quite rare within the Hudson Valley. The priority conservation zone widths (see Table 3) are designed to help maintain the integrity of the habitats by providing a protective buffer. We reviewed the scientific literature to determine the buffer zone widths needed to effectively filter sediments, nutrients, and other contaminants from runoff, stabilize stream banks, prevent channel erosion, regulate habitat temperature and microclimate, and protect important ecosystem process.

In many cases, the priority zone for a particular habitat partially overlapped the priority zones for other habitats. We merged the individual priority zones together to make the final presentation easier to interpret. It is important to remember, however, that the priority zone and accompanying conservation recommendations for a given habitat apply to the entire extent of that habitat, even areas that extend into or are encompassed by the priority zone of another habitat.

Priority Conservation Zones

The nine priority conservation zones that we identified in the study area are depicted in figures 5-11. Many of these zones occur in two or all three towns within the study area, but a few occur in just one town. The priority conservation zones within each municipality are:

- Town of Beekman: Priority zones 1, 2, 3, 4, 8, and 9
- Town of LaGrange: Priority zones 2, 3, 4, 5, 8, and 9
- Town of Fishkill: Priority zones 1, 3, 4, 5, 6, 7, 8, and 9
- City of Beacon: Priority zones 4, 7, 8, and 9

Table 3. Special habitats, species of concern, and associated priority conservation zones identified by Hudsonia in the Fishkill and Sprout Creek corridors, towns of Beekman, LaGrange, and Fishkill, and the City of Beacon, Dutchess County, New York.

Special Habitat	Associated Species of Concern	Priority Conservation Zone Width	Rationale	References
oak-heath barren	northern copperhead *	1000 meters	Encompasses most of the summer foraging habitat.	Fitch 1960
kettle shrub pool	Blanding's turtle*	1000 meters	Encompasses most of the essential habitat complex including nesting areas, summer foraging wetlands, drought refuge pools and overland travel corridors.	Kiviat 1997, Hartwig et al. in prep.
fen & calcareous wet meadow	bog turtle*	750 meters	Represents the reported overland distance traveled between wetlands within a habitat complex. Also encompasses the recommended "Bog turtle Conservation Zone" aimed at protecting habitat integrity.	Eckler et al. 1990 Klemens 2001
Fishkill & Sprout creeks & riparian zone	wood turtle*	200 meters	Encompasses most of the core habitat including nesting areas, spring basking sites, foraging habitat, and overland travel corridors	Carroll and Ehrenfeld 1978, Harding and Bloomer 1979, Buech et al. 1997, Foscarini and Brooks 1997
intermittent woodland pool	pool breeding amphibians*	230 meters	Encompasses non-breeding season foraging and refuge habitats and most dispersal routes between pools.	Downs 1989, Madison 1997, Semlitsch 1998, Calhoun and Klemens 2002
intertidal marsh & mudflat	breeding marsh birds*	200 meters	Minimizes human-induced flushing and habitat avoidance.	Selected values reviewed in Rodgers and Smith 1997
acidic bog	----	200 meters	Provides a protective buffer for filtering sediment, nutrients, and contaminants, and attenuating surface water runoff.	Priority zone designed based on bog's sensitivity (e.g. Wilcox 1986)
streams	----	50 meters	Provides a protective buffer for filtering sediment, nutrients, and contaminants from runoff, stabilizing stream banks, preventing channel erosion, regulating microclimate, and protecting ecosystem processes.	Young et al. 1980, Hewlett and Fortson 1982, Steinblums et al. 1984, Lynch et al. 1985, McDade et al. 1990, Spence et al. 1996.

* Species of conservation concern. See Appendix A.

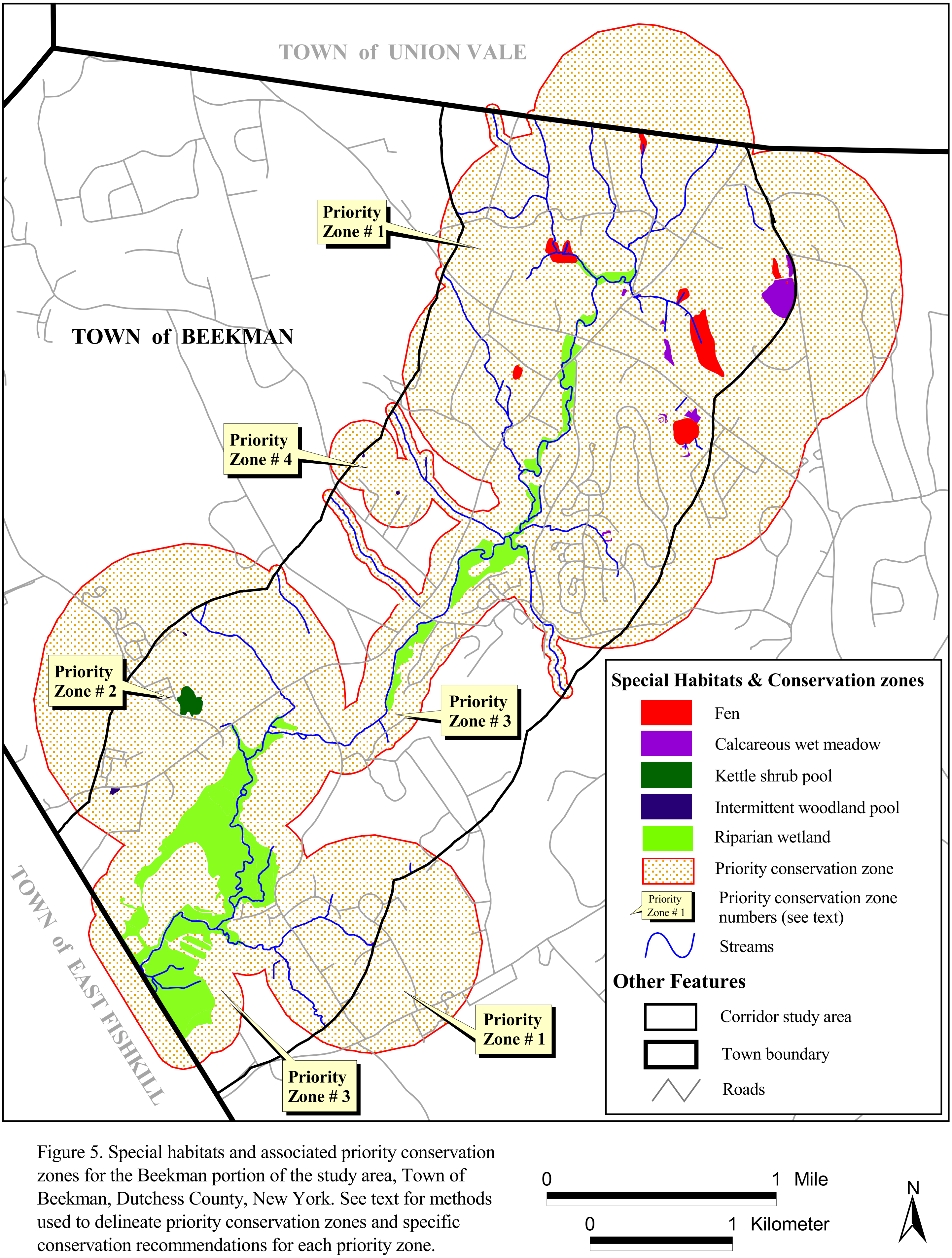


Figure 5. Special habitats and associated priority conservation zones for the Beekman portion of the study area, Town of Beekman, Dutchess County, New York. See text for methods used to delineate priority conservation zones and specific conservation recommendations for each priority zone.
Hudsonis Ltd., © 2005

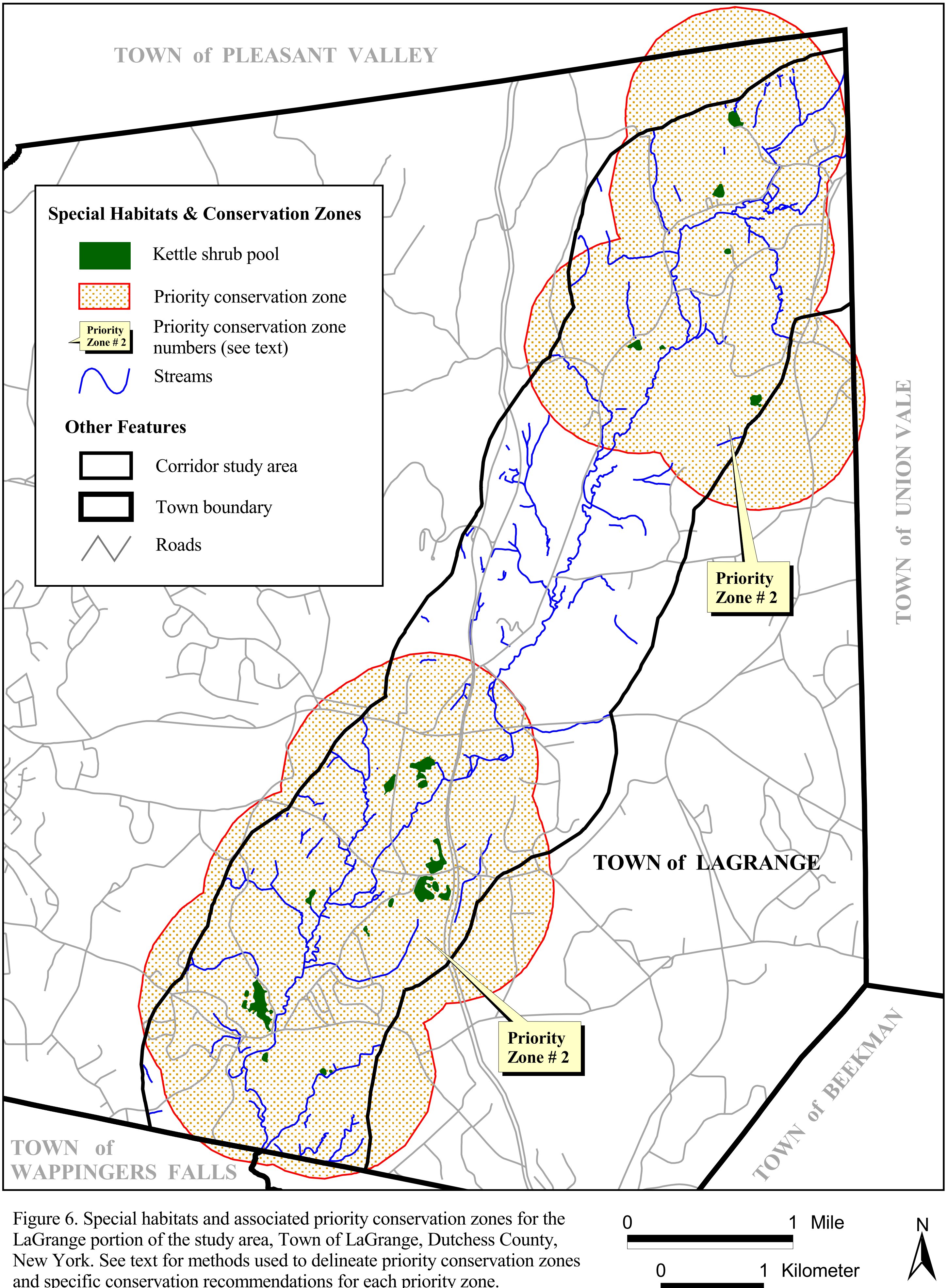


Figure 6. Special habitats and associated priority conservation zones for the LaGrange portion of the study area, Town of LaGrange, Dutchess County, New York. See text for methods used to delineate priority conservation zones and specific conservation recommendations for each priority zone.

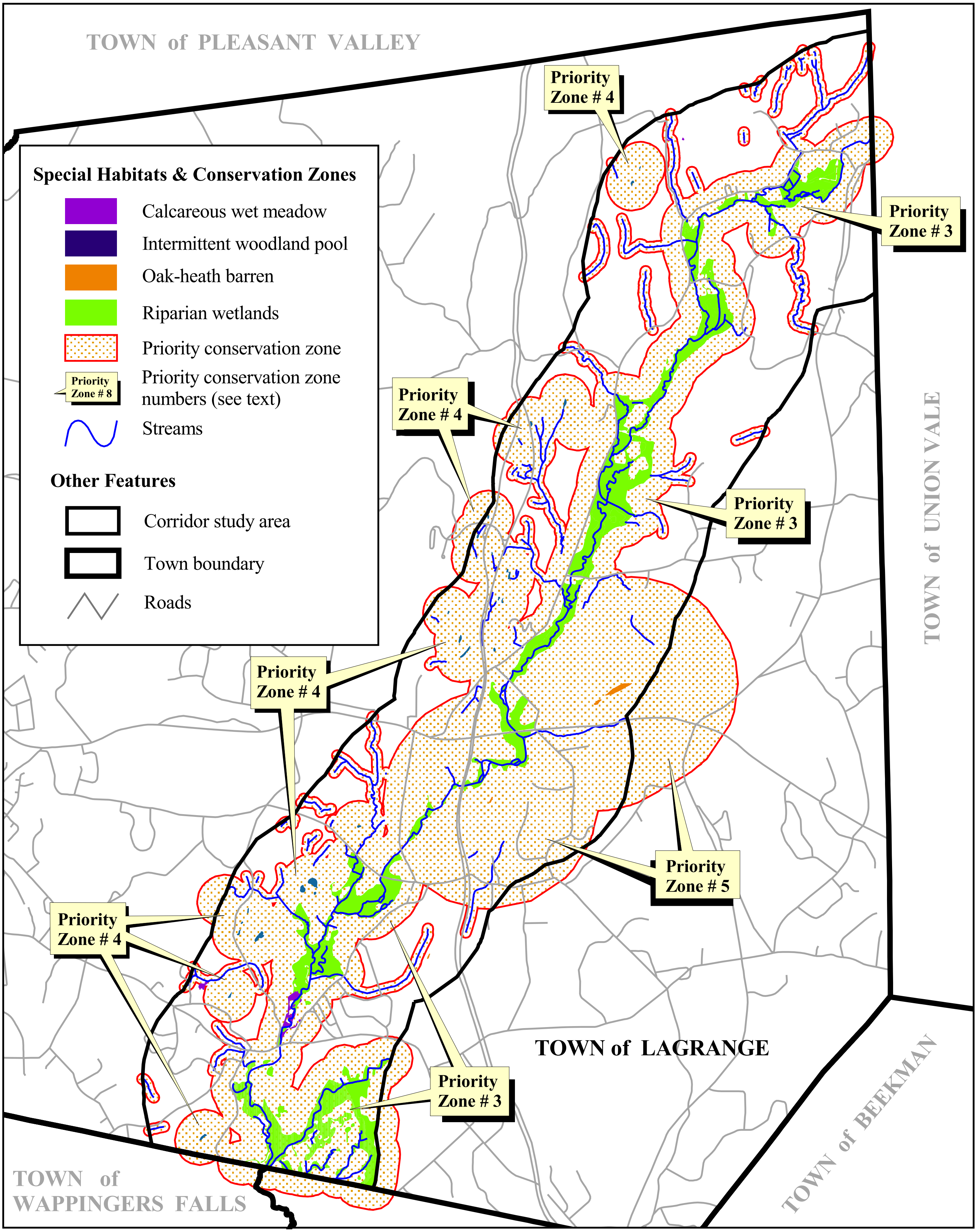


Figure 7. Special habitats and associated priority conservation zones for the LaGrange portion of the study area, Town of LaGrange, Dutchess County, New York. See text for methods used to delineate priority conservation zones and specific conservation recommendations for each priority zone. Hudsonia Ltd., © 2005

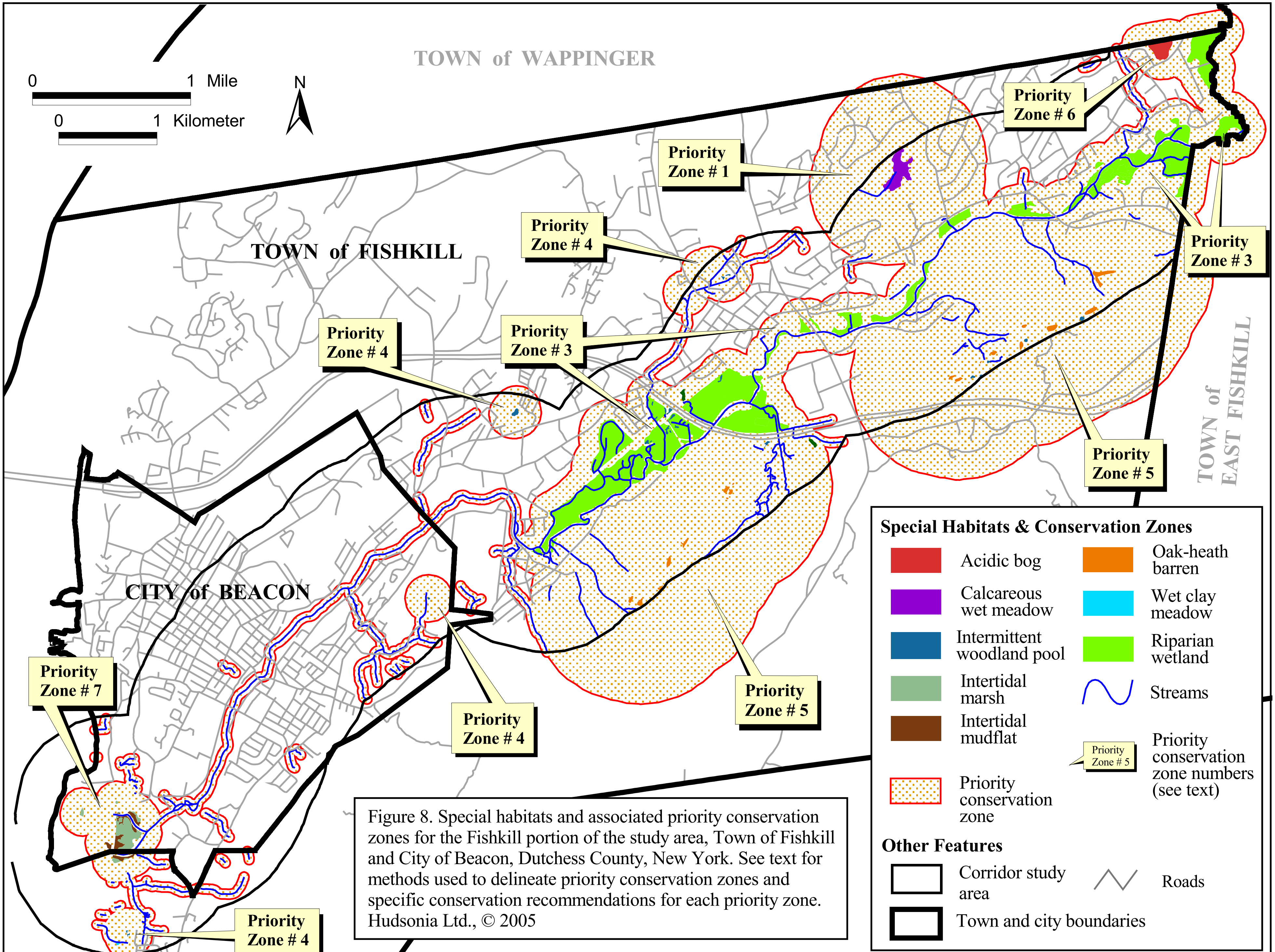


Figure 8. Special habitats and associated priority conservation zones for the Fishkill portion of the study area, Town of Fishkill and City of Beacon, Dutchess County, New York. See text for methods used to delineate priority conservation zones and specific conservation recommendations for each priority zone. Hudsonia Ltd., © 2005

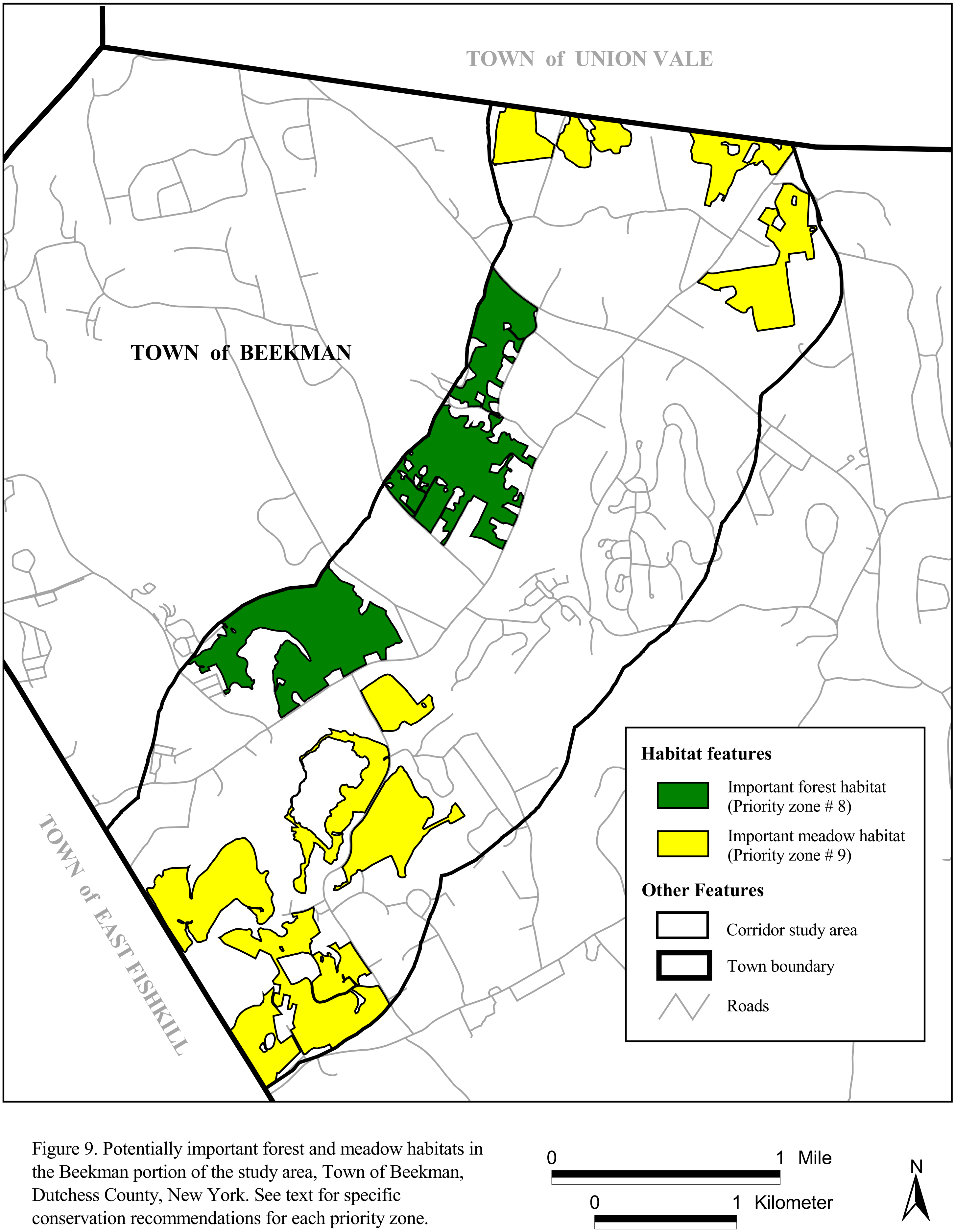


Figure 9. Potentially important forest and meadow habitats in the Beekman portion of the study area, Town of Beekman, Dutchess County, New York. See text for specific conservation recommendations for each priority zone. Hudsonis Ltd., © 2005

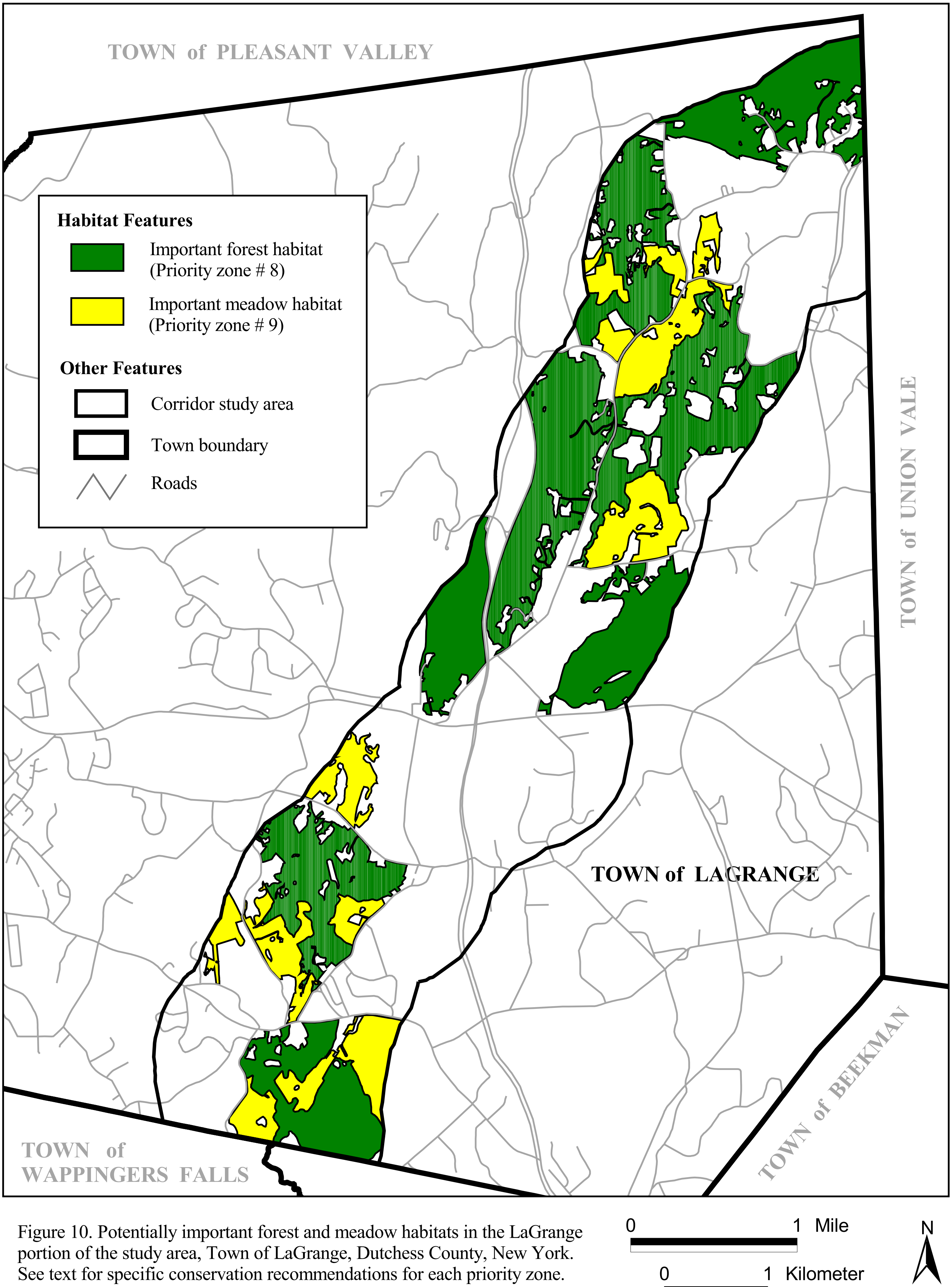


Figure 10. Potentially important forest and meadow habitats in the LaGrange portion of the study area, Town of LaGrange, Dutchess County, New York. See text for specific conservation recommendations for each priority zone. Hudsonia Ltd., © 2005

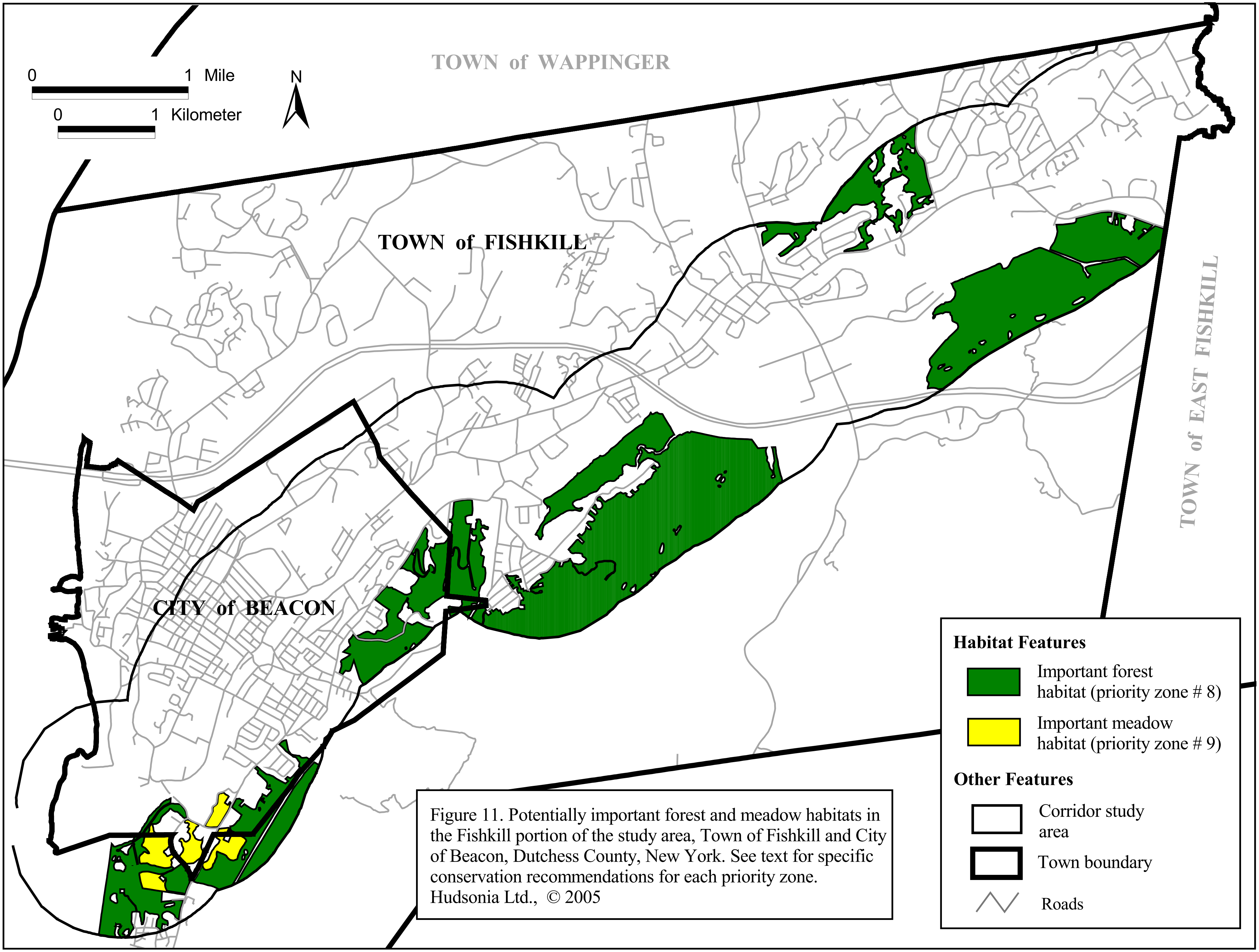


Figure 11. Potentially important forest and meadow habitats in the Fishkill portion of the study area, Town of Fishkill and City of Beacon, Dutchess County, New York. See text for specific conservation recommendations for each priority zone. Hudsonia Ltd., © 2005

The target habitats, conservation issues and specific recommended actions for each priority zone are summarized below.

- ### *Priority Zone 1: Fens and Calcareous Wet Meadows*

Target Habitats: This zone encompasses 10 fens and 11 calcareous wet meadows in the Beekman portion of the study area, one calcareous wet meadow in the Fishkill portion of the study area, and all upland and wetlands habitats within 2,500 ft (750 m) of those fens and wet meadows.

Conservation Issues: Fens and calcareous wet meadows are uncommon in the Hudson Valley and many provide important habitat to a number of plant and animal species of conservation concern (see Appendix A). We believe the fens and calcareous wet meadows in priority zone 1 have a high potential for supporting rare species due to their low invasive species cover and intact habitat structure. We discovered a population of swamp birch (NYS Threatened) in one of these fens during our field work for this project.

One of the most imperiled species associated with fens in Dutchess County is the bog turtle, listed as Endangered in New York and Threatened on the federal list. Suitable habitat for this species was observed in all of the mapped fens. We recommend, therefore, that the fens and calcareous wet meadows in priority zone 1 be considered potential bog turtle habitat and that the special protective measures discussed below be implemented to safeguard the integrity of these sensitive habitats.

Recommendations: Fens are maintained by calcareous groundwater seepage. Alterations to the quality or quantity of groundwater or surface water feeding the fen can alter the vegetation structure or plant community composition, and can render the habitats unsuitable for the bog turtle and other species of conservation concern. Thus, even if the fen footprint is not disturbed, activities in areas surrounding a fen can affect the fen habitat. Furthermore, although bog turtles spend most of their lives in fens and associated wetlands, they also require safe travel corridors between fens for dispersal and other long-term migrations.

To help protect the integrity of these habitats and the long-term viability of the bog turtle, the US Fish and Wildlife Service recommends the following (excerpted from Klemens [2001]):

1) *Protect wetland habitat*. The entire wetland, not just those portions that have been identified as, or appear to be, optimal for nesting, basking, or hibernating, should be protected from direct destruction and degradation. The following activities (not an inclusive list) should be avoided within the wetland:

   - Development of roads, residences, driveways, parking lots, sewer lines, utility lines, stormwater or sedimentation basins, and other structures.
   - Wetland draining, ditching, tiling, filling, excavation, stream diversion, and construction of impoundments.
   - Herbicide, pesticide, or fertilizer application (except as part of approved bog turtle management plan)
   - Mowing or cutting of vegetation (except as part of approved bog turtle management plan)
   - Delineation of lot lines for development, even if the proposed building or structure will not be in the wetland.

2) *Establish 300 ft buffer zone*. A 300 ft (91 m) wide protective "buffer" should be established around known or potential bog turtle wetlands to help prevent or minimize the effects of land-use activities. Activities in this zone could indirectly destroy or degrade the habitat over the short or long term and should be thoroughly evaluated in consultation with the US Fish and Wildlife Service and the New York State Department of Environmental Conservation. Activities in this zone that may adversely impact bog turtles and their habitats include, but are not limited to, the following:

   - Development of roads, residences, driveways, parking lots, sewer lines, utility lines, stormwater or sedimentation basins, and other structures.
   - Mining.
   - Herbicide, pesticide, or fertilizer application.
   - Farming (with the exception of light to moderate grazing).
   - Stream bank stabilization (e.g. rip-rapping).
   - Delineation of lot lines for development, even if the proposed building or structure will not be in the wetland.

3) *Assess potential impacts at least one-half mile beyond buffer zone.* Despite the distance, development activities occurring within the drainage basin of the fen or at least one-half mile from the boundary of the buffer zone may adversely affect bog turtles and their habitat. Activities such as the construction of roads and other impervious surfaces, groundwater extraction (e.g. wells), septic/sewer facilities, and mining have a high potential to alter the hydrology and chemistry of the fen habitat. Development within this area may also sever important travel corridors between wetlands occupied or likely to be occupied by bog turtles, thereby isolating populations and increasing the likelihood of road mortality as turtles attempt to disperse.

In New York, bog turtles may travel overland 2,500 ft (750 m), or nearly one-half mile, between individual wetlands within a habitat complex (Eckler et al. 1990). Maintaining connections to other wetland habitats within a one-half mile radius of a known or potential bog turtle habitat may be crucial to sustaining the long-term genetic viability of bog turtle populations and the ability of individuals to relocate as habitat quality changes. We believe the construction of new roads and bridges should be avoided within this radius. Existing roads with medium to high volume traffic may be ideal candidates for "turtle underpasses" that may provide safer travel passageways for this species.

Priority conservation zone 1 (see figures 5 and 8) encompasses a 2,500 ft (750 m) wide area around the mapped fens and calcareous wet meadows representing the minimum extent of the potential bog turtle habitat complex. We strongly recommend that all activity proposed within this zone be thoroughly reviewed in consultation with the Endangered Species Unit of the New York State Department of Environmental Conservation using the most up-to-date scientific information on this species and its sensitive habitat.

➢ *Priority Zone 2: Kettle Shrub Pools*

Target Habitats: This zone encompasses 19 kettle shrub pools in the LaGrange portion of the study area, a single kettle shrub pool in the Beekman portion of the study area, and all upland and wetland habitats within 3,300 ft (1,000 m) of the pools' boundaries.

Conservation Issues: Kettle shrub pools are an essential part of the core habitat of the Blanding's turtle (NYS Threatened). This turtle uses kettle shrub pools for winter hibernation and spring basking. During other times of the year, Blanding's turtles use kettle shrub pools and a variety of other wetlands in the surrounding landscape for foraging, shelter, and drought refuge. Females also migrate long distances from their core wetlands to nest in open (non-wooded) upland areas with loose, coarse-textured soils and sparse vegetation.

Suitable habitat for the Blanding's turtle was observed in all of the kettle shrub pools within priority zone 2. We recommend, therefore, that the special protective measures discussed below be implemented in priority zone 2 to safeguard the integrity of this species and its habitat.

Recommendations: Maintaining a Blanding's turtle population requires protecting not only the core wetland habitats (e.g. kettle shrub pools), but also the associated foraging and drought refuge wetlands, the upland nesting areas, and the upland areas between these habitats. The Blanding's turtle habitat complex can encompass the wetland and upland habitats within 3,300 ft (1000 m) or more of a kettle shrub pool (Kiviat 1997, Hartwig et al. in prep.). Development activity within this habitat complex can have significant adverse effects on the turtles and their habitats, including the direct loss of wetland habitat (especially small, unregulated wetlands), degraded water quality from pesticides, fertilizers, and toxic compounds, altered wetland hydroperiod and water depth from groundwater extraction, habitat fragmentation from roads and developed land uses, increased nest predation by human-subsidized predators, and greater road mortality of nesting females and other individuals migrating between habitats.

To help protect Blanding's turtles and the habitat complex they require, we recommend the following measures within priority zone 2 (adapted from Hartwig et al., in prep.):

1) *Protect wetland habitats*. All wetland habitats within a minimum of 3,300 ft (1,000 m) of a known or potential Blanding's turtle wetland should be protected from filling, dumping, drainage, incursion of construction equipment, siltation, polluted runoff, and hydrological alterations.

2) *Establish 660 ft buffer around core habitat*. Blanding's turtles regularly use upland areas within 660 ft (200 m) of a kettle shrub pool habitat for basking, estivation (rest during periods of hot dry weather), and short-distance travel. A 200 m wide buffer of natural vegetation and soil will minimize direct impacts to these individuals, help maintain wetland

hydrology and water temperature, and filter runoff containing silt and other pollutants. We recommend that no buildings, pavement, roads, or other structures be constructed within this protective buffer zone.

3) *Minimize impacts from new and existing roads*. Road mortality of nesting females and individuals migrating between wetlands or dispersing to new habitats is one of the greatest threats to Blanding's turtle populations. To help minimize the adverse affects of roads on this species, we recommend the following actions be undertaken within this 1,000 m wide priority conservation zone:

    - Prohibit the building of new roads crossing or adjoining Blanding's turtle habitat complexes. This applies to public and private roads of all kinds including driveways.
    - Keep vehicle speeds low on new and existing roads by installing speed bumps, low speed limit signs, and wildlife crossing signs.
    - Medium and heavy volume roads within the priority zone should be considered as candidates for turtle underpasses. Adult Blanding's turtles have been observed using culverts to pass under highways; however, no drift fence or underpass system has ever been specifically constructed for Blanding's turtles and proven to function successfully. Given this uncertainty, we recommend that underpass systems be considered as a last resort if construction of new roads or increased traffic cannot be avoided.

4) *Maintain broad corridors between habitats and habitat complexes.* Blanding's turtles travel overland on a day-to-day or seasonal basis to reach important foraging areas, nesting sites, overwintering areas, and refuge habitats within the surrounding landscape. These regular movements can encompass an area up to 3,300 ft (1000 m) from a core wetland habitat. Long distance dispersal greater than 3,300 ft from a core wetland occur on a less-than-annual basis, but are equally important to the long term viability of Blanding's turtle populations within a landscape. These long distance dispersals enable turtles to select alternative habitats as habitat quality or social dynamics change, and to breed with populations from neighboring habitat complexes. Broad, naturally vegetated travel corridors should be maintained between individual habitats within a complex (e.g. between kettle shrub pools, foraging wetlands, drought refuge ponds, and nesting areas) and between neighboring habitat complexes.

5) *Protect nesting areas.* Blanding's turtles traditionally nest in upland meadow or open shrublands, habitats that also tend to be prime targets for development. Construction of roads, houses, and other structures on potential nesting habitats could severely limit the reproductive success of females over the long term. The loss of "traditional" nesting grounds might also force females to travel farther to find suitable nesting sites. This, in turn, can expose them to increased road mortality or collecting as they cross roads and developed areas. We recommend that large areas of potential nesting habitat within priority zone 2 (e.g. upland meadows, upland shrublands, waste grounds with exposed gravelly soils) be permanently protected from development and other disturbance. These areas, however, may need to be managed as part of an approved management plan to maintain suitable nesting conditions.

In addition to the recommendations discussed above, local and state agencies should require the following of any proposed development project within priority conservation zone 2:

1) Potential pitfall hazards such as window wells, storm drains, catch basins, swimming pools, and silt fencing should be designed or modified to prevent the entrapment of turtles. For example:

    - Window wells should have either permanent grates (maximum 1 in [2.5 cm] mesh size) or lips at least 10 in (25 cm) high so Blanding's turtles of carapace length up to 10 inches cannot climb over and become trapped.

- Fences or other barriers should be constructed around in-ground swimming pools to keep turtles of any size out of the pools. Barriers must exclude turtles as small as 1 in (2.5 cm) carapace length, and must be at least 10 in (25 cm) high to exclude turtles up to 10 inches carapace length.

- Storm drains should be designed or retrofitted so that turtles, including hatchlings of carapace length 1 in (2.5 cm), cannot fall in.

- Coarse-mesh backing on filter fabric silt fencing (e.g. 0.8-1.2 in [2-3 cm] square mesh size) can trap turtles and snakes and should not be used on construction sites within this zone. Erosion control fabrics, geotextiles, or landscaping fabrics should be selected as to not present an entanglement hazard to turtles.

- Immediate (same day) backfilling of any excavations (e.g. soil test pits, foundation holes, utility ditches) should be established, or else gently sloping (e.g. 30° or less from horizontal) earthen or wooden ramps should be installed to allow turtles to climb out.

2) Potential barriers to turtle movement either on land or in the water should be designed with spaces or openings to allow safe turtle passage. Such potential barriers include stone walls, chain-link fences, and curbs. Spaces must be no less than 4 in (10 cm) high and no more than 82 ft (25 m) apart to allow turtles to move freely across the landscape (fences around swimming pools and other pit fall hazards discussed above are excluded).

3) Construction crews and eventual residents should be educated on how to look for and safely move turtles under cars, construction equipment, or mowing machines before operating or driving.

4) Under certain circumstances (to be determined on a case-by-case basis by the New York State Department of Environmental Conservation or a Blanding's turtle specialist), temporary exclusion fencing should be erected around a construction site to keep Blanding's turtles out of the work area. This pertains especially to construction areas that are within 660 ft (200 m) of a Blanding's turtle wetland, or construction areas that may be situated between wetlands and nesting areas if construction is to occur between 25 May and 10 July (the nesting season). Temporary exclusion fencing should consist of small-mesh filter fabric with the bottom buried 8 in (20 cm) deep in the soil. These fences should be regularly maintained so that turtles of all sizes are unable to pass through or climb over.

Priority conservation zone 2 (see figures 5 and 6) represents the minimum extent of the potential Blanding's turtle habitat complex. We strongly recommend that all activity proposed within this zone be thoroughly reviewed in consultation with the Endangered Species Unit of the New York State Department of Environmental Conservation using the most up-to-date scientific information on this species and its habitat requirements.

- *Priority Zone 3: Fishkill Creek and Sprout Creeks*

Target Habitats: This zone encompasses Fishkill Creek in the Town of Beekman, Sprout Creek in the Town of LaGrange, and the eastern half of Fishkill Creek in the Town of Fishkill, all associated riparian wetlands, and all upland habitats within 660 ft (200 m) of these stream channels and wetlands. The portion of Fishkill Creek flowing through highly developed areas in the City of Beacon was excluded from this priority zone.

Conservation Issues: Low gradient, perennial streams can be essential core habitat for the wood turtle, a Species of Special Concern in New York State. Wood turtles require streams with undercut banks, muskrat burrows, or other underwater shelter for winter hibernation. In early spring, wood turtles use overhanging tree limbs and stream banks for basking. In late spring and summer, however, wood turtles (especially females) move into the surrounding riparian zone to bask and forage in a variety of wetland and upland habitats, and females travel long distances from their core stream habitat to find open, sparsely vegetated upland nesting habitats.

We observed four female wood turtles along Fishkill Creek and Sprout Creek during our field work for this project and observed suitable habitat for this species along most parts of these streams. We recommend, therefore, that the portions of Fishkill Creek and Sprout Creek included in priority zone 3 be considered core wood turtle habitat and that the special protective measures discussed below be implemented to safeguard the integrity of these habitats.

Recommendations: Conserving wood turtles requires protecting not only their core habitat (e.g. perennial streams), but also their riparian wetland and upland foraging habitats, the upland nesting areas, and the upland migration corridors between these habitats. The wood turtle habitat complex can encompass the wetland and upland habitats within 660 ft (200 m) or more of a core stream habitat. Development activity within this habitat complex can have significant adverse affects on wood turtles and their habitats, including habitat degradation from stream alteration;

habitat fragmentation from culverts, bridges, roads, and other structures; the direct loss of wetland habitat, degraded water quality from siltation, pesticides, fertilizers, and toxic compounds; increased nest predation by human-subsidized predators; disturbance from human recreational activities; and higher road mortality of nesting females and other individuals migrating between habitats.

To help protect wood turtles and the habitat complex they require, we recommend that the following measures be employed within priority zone 3:

1) *Protect integrity of stream habitats*. Wood turtles are particularly sensitive to disturbance or change in their core stream habitats. Engineering practices that alter the physical structure of the stream channel (e.g. stream channelization, bank stabilization) can destroy key hibernation and basking habitat. These activities may also alter the complex hydrological and stream channel dynamics that help maintain wood turtle habitat over the long-term. To help protect the core stream habitats within this priority zone, we advise the following:

    - Activities such as stream channelization, artificial stream bank stabilization (e.g. rip-rap, concrete), construction of dams or artificial weirs, vehicle crossing (e.g. from construction or logging equipment, ATVs), and the clearing of natural stream bank vegetation should be prohibited within streams in this zone.

    - Direct discharge of stormwater runoff, chlorine-treated wastewater, agricultural by-products, and other potential pollutants should be avoided or minimized to the greatest extent possible.

    - A minimum 160 ft (50 m) wide protective buffer zone should be established on all streams in the watershed, including perennial and intermittent tributary streams, regardless of whether or not they are used by wood turtles. Such a buffer zone will help stabilize stream banks, prevent channel erosion, filter sediments, nutrients, and other contaminants from runoff before it enters the stream, regulate stream temperature and microclimate, and provide important woody debris and leaf litter to the stream ecosystem. This, in turn, would help maintain or improve the quality of wood turtle, trout, and other wildlife habitat in streams within priority zone 3. Buffer zones should remain naturally vegetated to provide the greatest benefit possible. Disturbance within the buffer zone should be avoided, including construction of any kind, conversion to impervious surfaces, agriculture and livestock use, pesticide and fertilizer application, and installation of septic leachfields or other waste disposal facilities.

2) *Protect riparian wetland and upland habitats.* All riparian wetlands adjacent to known or potential wood turtle streams should be protected from filling, dumping, drainage, incursion of construction equipment, siltation, polluted runoff, and hydrological alterations. In addition, large, contiguous blocks of upland habitats (e.g. forests, meadows, shrublands) within 660 ft (200 m) of a core wood turtle stream should be preserved to the greatest extent possible to provide important foraging, basking, and nesting habitat for this species.

   Special efforts may need to be taken to protect particularly vulnerable components of the habitat complex such as wet meadows. Wet meadows are often sought after by wood turtles, especially females, for spring basking and foraging (Kaufmann 1992). These wetlands, however, are often omitted from state, federal, and site-specific wetland maps and are frequently overlooked in the environmental reviews of development proposals. We strongly recommend that wet meadows and other wetlands within priority zone 3 be accurately delineated, and their potential for wood turtle habitat be fully considered during environmental reviews of development projects.

3) *Minimize impacts from new and existing stream crossings.* Stream crossings, particularly undersized bridges and narrow culverts, may be significant barriers to wood turtle movement along their core stream habitats. Wood turtles may shy away from entering such structures and choose an overland route to reach their destination. Typically, this overland route involves crossing a road or other developed area—often resulting in road mortality. If a stream crossing completely blocks the passage of turtles, individuals can be cut off from important foraging or nesting habitats, or be unable to interbreed with neighboring wood turtle populations. Such barriers could significantly diminish the long-term viability of these populations.

We recommend that no new stream crossings (roads) be constructed within priority zone #3. If new crossings cannot be avoided, or if old bridges and culverts are scheduled to be upgraded, we suggest that they be specifically designed to accommodate the passage of turtles and other wildlife. We believe the following specifications, although not specifically designed for wood turtles, may be an important first step to improving the connectiveness of stream corridors (adapted from Singler and Graber 2005):

- Use bridges and open-bottomed arches instead of culverts.
- Use structures that span at least 1.2 times the bank-full width of the stream so that one or both banks remain in a semi-natural state beneath the structure. This may promote the overland passage of turtles and other wildlife.
- The structure should be a minimum of 4 ft (1.2 m) in height and have an openness ratio of at least 0.5 (openness ratio = the cross-sectional area of the structure divided by its length, measured in meters). Higher openness ratio values mean that more light is able to penetrate into the interior of the crossing. Brighter conditions beneath a crossing may be more favorable for the passage of animals including wood turtles.
- The substrate within the structure should be composed of natural materials and match the texture and composition of upstream and downstream substrates. If possible, crossings should be installed in a manner that does not disturb the natural substrate of the stream bed.
- If the stream bed must be disturbed during construction, the final elevation and gradient of the structure bottom should be designed so as to maintain water depth and velocities at low flow that are comparable to those found in natural stream segments just upstream and downstream of the structure. Sharp drops in elevation at the inlet or outlet of the structure can be a physical barrier to wood turtle passage.

4) *Minimize impacts from new and existing roads*. Road mortality of nesting females and individuals dispersing to new habitats is one of the greatest threats to wood turtle populations. To help minimize the adverse affects of roads on this species, we recommend the following actions be undertaken within this 200 m wide priority conservation zone:

- Prohibit the building of new roads crossing or adjoining wood turtle habitat complexes. This applies to public and private roads of all kinds including driveways.

- Keep vehicle speeds low on new and existing roads by installing speed bumps, low speed limit signs, and wildlife crossing signs.

5) *Maintain broad corridors between habitats and habitat complexes.* Wood turtles travel overland on a day-to-day or seasonal basis to reach important foraging grounds, nesting sites, over-wintering areas, and refuge habitats within the surrounding landscape. These regular movements can encompass an area extending 660 ft (200 m) or more from the core stream habitat. Long distance dispersal greater than 660 ft from a core stream occur less frequently, but are equally important to the long term viability of wood turtle populations within a landscape. These long distance dispersals enable turtles to select alternative habitats as habitat quality or social dynamics change, and to breed with populations from neighboring habitat complexes. Broad, naturally vegetated travel corridors should be maintained between individual habitats within a complex (e.g. between core stream habitats, foraging wetlands, and nesting areas) and between neighboring habitat complexes.

6) *Protect nesting areas.* Wood turtles typically nest in upland meadow or open shrublands, habitats that also tend to be prime areas for development. Construction of roads, houses, and other structures on potential nesting habitats could severely limit the reproductive success of females over the long term. The loss of "traditional" nesting grounds might also force females to travel farther to find suitable nesting sites. This, in turn, could expose them to increased road mortality or collecting as they cross roads and developed areas. We recommend that large areas of potential nesting habitat within priority zone 3 (e.g. upland meadows, upland shrublands, waste ground with exposed gravelly soils) be permanently protected from development and other disturbance.

In addition to the recommendations discussed above, local and state agencies should require the following of any proposed development project within priority conservation zone 3:

1) Potential pitfall hazards such as window wells, storm drains, catch basins, swimming pools, and silt fencing should be designed or modified to prevent the entrapment of turtles. For example:

   - Window wells should have either permanent grates (maximum 1 in [2.5 cm] mesh size) or lips at least 10 in (25 cm) high so wood turtles of carapace length up to 10 inches cannot climb over and become trapped.

   - Fences or other barriers should be constructed around in-ground swimming pools to keep turtles of any size out of the pools. Barriers must exclude turtles as small as 1 in (2.5 cm) carapace length and must be at least 10 in (25 cm) high to exclude turtles up to 10 inches carapace length.

   - Storm drains should be designed or retrofitted so that turtles, including hatchlings of carapace length 1 in (2.5 cm) cannot fall in.

   - Coarse-mesh backing on silt fencing (e.g. 0.8-1.2 in [2-3 cm] square mesh size) can trap turtles and snakes and should not be used on construction sites within this zone. Erosion control fabrics, geotextiles, or landscaping fabrics should be selected as to not present an entanglement hazard to turtles.

   - Immediate (same day) backfilling of any excavations (e.g. soil test pits, foundation holes, utility ditches) should be established, or else gently sloping (e.g. 30^{o} or less from horizontal) earthen or wooden ramps should be installed to allow turtles to climb out.

2) Potential barriers to turtle movement either on land or in the water should be designed with spaces or openings to allow safe turtle passage. Such potential barriers include stone walls, chain-link fences, and curbs. Spaces must be no less than 4 in (10 cm) high and no more than 82 ft (25 m) apart to allow turtles to move freely across the landscape (exceptions are barrier fences around swimming pools and other pit fall hazards discussed above).

3) Construction crews and eventual residents should be educated on how to look for and safely move turtles found under or in front of cars, construction equipment, or mowing machines before operating or driving.

4) Under certain circumstances (to be determined on a case-by-case basis by the New York State Department of Environmental Conservation or a turtle specialist), temporary exclusion fencing should be erected around a construction site to keep wood turtles out of the work area. This pertains especially to construction areas that are within 660 ft (200 m) of a wood turtle stream, or construction areas that may be situated between riparian systems and nesting areas if construction is to occur between 25 May and 10 July (the nesting season). Temporary exclusion fencing should consist of filter fabric with the bottom buried 8 in (20 cm) deep in the soil. These fences should be regularly maintained so that turtles of all sizes are unable to pass through.

Priority conservation zone 3 (see figures 5, 7, and 8) represents the minimum extent of the potential wood turtle habitat complex within the study area. It is important to note that we did not assess the habitat suitability of the many tributaries to Fishkill Creek and Sprout Creek, and that some of these tributaries may also provide core habitat for the wood turtle. We strongly recommend that all activity proposed within priority zone 3 be thoroughly reviewed in consultation with the Endangered Species Unit of the New York State Department of Environmental Conservation using the most up-to-date scientific information on this species and its habitat requirements.

- *Priority Zone 4: Intermittent Woodland Pools*

Target Habitats: This zone encompasses all intermittent woodland pools mapped within the study area (31 pools in LaGrange, 29 in Fishkill, and 5 in Beekman) and all upland forest habitat within 750 ft (230 m) of the pools' boundaries.

Conservation Issues: Intermittent woodland pools provide crucial breeding and nursery habitat for several amphibian species that cannot successfully reproduce in other wetlands. Two of these amphibians, Jefferson salamander and marbled salamander, are listed as Species of Special Concern in New York State. We consider the spotted salamander and wood frog to be regionally vulnerable due to the loss of woodland pool and upland forest habitats. During the non-breeding season, these amphibians are exclusively terrestrial and require the deep shade, thick leaf litter, uncompacted soil and coarse woody debris of the surrounding upland forest for foraging and shelter. Thus, both the intermittent woodland pool and the surrounding forest are essential for these species to complete their life cycle.

We observed wood frog tadpoles and egg masses of spotted salamander and Jefferson/blue-spotted salamander in intermittent woodland pools in the study area. Other woodland pools visited during the non-breeding season appeared to contain suitable breeding habitats for these amphibians. We recommend, therefore, that the intermittent woodland pools in priority zone 4 be considered important amphibian breeding habitat and that the special protective measures discussed below be implemented to safeguard these species and their habitats.

Recommendations: Protecting the salamander and frog species associated with intermittent woodland pools requires protecting not only their core breeding habitat (i.e. the intermittent woodland pool), but also their key foraging and wintering habitats in the surrounding upland forests, and the forested migration corridors between individual pools and pool complexes. The upland habitat of pool breeding amphibians can encompass an area 750 ft (230 m) or more from the edge of the woodland pool. Disturbance of vegetation or soils within this area can have significant adverse effects on the amphibians, including the direct loss of pool and forest habitats, alteration of the pool hydroperiod, degradation of pool water quality, degradation of forest floor microhabitats, isolation of woodland pools from other pools and habitats, and increased road mortality of animals migrating among pools and between pools and upland habitats.

To help protect pool breeding amphibians and the habitat complex they require, we recommend that the following protective measures be taken within priority zone 4 (adapted from Calhoun and Klemens 2002, Calhoun and deMaynadier 2004):

1) *Protect the intermittent woodland pool depression*. Intermittent woodland pools are often overlooked during environmental reviews of proposed development projects and are frequently drained, filled, or dumped in. Some that are not directly destroyed may be excavated by future homeowners to create an ornamental pond. These activities severely diminish the reproductive success of intermittent woodland pool breeding amphibians and threaten the long-term viability of these populations within the larger landscape.

   We advise that intermittent woodland pools be permanently protected from development and disturbance of any kind including the construction of houses, roads, lawns, and ponds within the pool depression. This zone of protection should include the pool basin up to the spring high water mark and all associated vegetation. The soil in and surrounding the pool should not be compacted in any manner and the vegetation within the pool should not be removed.

2) *Protect all upland forest within 100 ft of the intermittent woodland pool.* Maintaining the integrity of the forest habitats within 100 ft (30 m) of a woodland pool is crucial to sustaining the pool's ecological and biodiversity potential. This zone provides important shelter for high densities of adult and recently emerged salamanders and frogs during the spring and early summer. The forest in this zone also helps shade the pool, maintains pool water quality, and provides important leaf litter and woody debris to the pool system. This organic debris constitutes the base of the pool food web and serves as attachment sites for amphibian egg masses.

   To further safeguard intermittent woodland pool habitats and their associated pool breeding amphibians, we recommend that all upland forest habitats within 100 ft (30m) of the pool's spring high water mark be protected in their entirety from development and disturbance of any kind including, but not limited to, clearing, excavation, site grading, and the construction of houses, roads, stormwater detention basins, and other structures. The forest habitat around a pool should remain undisturbed, including the canopy and understory vegetation, the leaf litter and woody debris layer, and the soil.

3) *Maintain critical terrestrial habitat within 750 ft of the pool*. The upland forests within 750 ft (230 m) or more of a woodland pool are critical foraging and shelter habitats for pool breeding amphibians during the non-breeding season. Roads, development, logging, ATV use, and other activities within this critical terrestrial habitat can crush a large number of amphibians and destroy the forest floor microhabitats that provide shelter and invertebrate food to the amphibians. Development within this zone can also prevent dispersal and genetic exchange between neighboring pools, thereby making local extinction more likely. It is important, therefore, that the critical terrestrial habitat be preserved to the greatest extent possible.

   We recommend that no more than 25 percent of the total critical terrestrial habitat (i.e. the area 750 ft from pool's seasonal high water mark) be developed or otherwise disturbed. A minimum of 75 percent of this zone should remain in contiguous (unfragmented) forest with an undisturbed forest floor. Wherever possible, forested connections between individual pools should be identified and maintained to provide overland dispersal corridors.

We also recommend the following guidelines for all development activity proposed within the critical terrestrial habitat zone of an intermittent woodland pool:

1) Avoid or minimize the potential adverse affects of roads to the greatest extent possible. Pool breeding salamanders and frogs are especially susceptible to road mortality from vehicular traffic, predation, and desiccation. Curbs and other structures associated with roads frequently intercept and funnel migrating amphibians into stormwater drains where they may be killed. To minimize these potential adverse impacts:

- Roads and driveways with projected traffic volumes in excess of 5-10 vehicles per hour should not be sited within 750 ft (230 m) of the pool.

- Regardless of traffic volumes, the total length of roads within 750 ft of a woodland pool should be limited to the greatest extent possible. This can be achieved, among other ways, by clustering development to reduce the amount of needed roadway.

- "Cape Cod" style curbs or no-curb alternatives should be used to reduce barriers to amphibian movement.

- Over-sized square box culverts (2 ft wide by 3 ft high) should be used near wetlands and known amphibian migration routes to facilitate amphibian movements under roads. These culverts should be spaced at 20 ft (6 m) intervals. Special "curbing" should also be used along the adjacent roadway to deflect amphibians into the box culverts.

2) Maintain woodland pool water quality and quantity at pre-disturbance levels. Development within a woodland pool's drainage basin can degrade pool water quality by increasing sediment, nutrient, and pollutant loading to the pool. Even slight increases in sediment or pollution can stress and kill amphibian eggs and larvae and may have adverse long-term affects on the adults. Activities such as groundwater extraction (e.g. wells) or the redirection of natural surface water flows can decrease the pool hydroperiod below the threshold required for successful egg and larval development. Increasing impervious surfaces or channeling stormwater runoff toward pools can increase pool hydroperiod, which can also adversely affect the ability of amphibians to reproduce successfully in woodland pools. Changes to pool water quality and flood regime should be avoided to the greatest extent possible. Some protective measures that would help achieve this are listed below:

- Do not use intermittent woodland pools for storm water detention, either temporarily or permanently.

- Aggressively treat stormwater using methods that allow for the maximum infiltration and filtration of runoff, including grassy swales, filter strips, and oil-water separators in paved parking lots.

- Avoid or minimize the use of pesticides, herbicides, and fertilizers within the woodland pool's drainage basin to the greatest extent possible.

- Maintain both surface water runoff and groundwater inputs to intermittent woodland pools at pre-construction levels. Avoid changes (either increases or decreases) in pool depth, volume, and hydroperiod.

- Minimize impervious surfaces including roads, parking lots, and buildings to reduce runoff problems and resulting stormwater management needs.

3) Avoid creating stormwater detention basins and other artificial depressions that intermittently hold water (e.g. vehicle ruts) within 750 ft (230 m) of an intermittent woodland pool or in areas that might serve as overland migration routes between pools. These "decoy wetlands" can attract large numbers of pool breeding amphibians, but the eggs laid in these water features rarely survive due to the high sediment and pollutant loads and short hydroperiod.

4) Design or modify potential pitfall hazards to prevent the entrapment and death of migrating amphibians. For example:

   - In-ground swimming pools located within the critical terrestrial habitat of a woodland pool should be surrounded by a protective barrier such as a fine mesh wire at the base of a picket fence or a 1 ft (0.3 m) high curb. These barriers must be continuously maintained for the life of the swimming pool.

   - Excavations such as soil test pits, foundation holes, and utility ditches should be immediately backfilled as soon as the test is complete or the need for the excavation is fulfilled.

5) Schedule construction activities to occur outside peak amphibian movement periods in spring and early summer. If construction activity during this time period cannot be avoided, temporary exclusion fencing should be installed around the entire site (in consultation with the New York State Department of Environmental Conservation) to keep amphibians out of the active construction areas. Temporary exclusion fencing should consist of woven filter fabric (without coarse-mesh backing) with the bottom buried 8 in (20 cm) deep in the

soil. These fences should be regularly maintained so that amphibians are unable to pass through or get entangled in the barrier.

Priority zone 4 (see figures 5, 7, and 8) represents the minimum extent of the potential pool breeding amphibian habitat complex within the study area. We strongly recommend that all activity proposed within this zone be thoroughly reviewed in consultation with the Endangered Species Unit of the New York State Department of Environmental Conservation using the most up-to-date scientific information on woodland pool breeding amphibians and their habitat requirements.

➢ *Priority Zone 5: Oak-Heath Barrens*

Target Habitats: This zone encompasses all oak-heath barren habitats mapped within the study area (18 barrens in Fishkill and 7 in LaGrange,) and all upland and wetland habitats within 3,300 ft (1,000 m) of the barrens.

Conservation Issues: Oak-heath barrens are uncommon in the Hudson Valley and may provide core habitat for several rare reptiles that require rocky outcrops and exposed conditions at crucial stages in their life cycle. These reptiles include northern copperhead, five-lined skink (both regionally vulnerable), and at least along portions of Fishkill Ridge outside the study corridor, timber rattlesnake and eastern fence lizard (both NYS Threatened). The five-lined skink and eastern fence lizard typically use oak-heath barrens and associated crest, ledge, and talus habitats throughout the year for basking, foraging, and shelter. Snakes, on the other hand, may only use these open rocky habitats at key times of the year, including for spring basking and breeding. During late spring and summer the copperhead, for example, may travel 3,300 ft (1,000 m) or more from these habitats to forage in the surrounding forests, wetlands, and fields. These species also occasionally disperse to nearby barrens to interbreed with neighboring populations (thereby maintaining the genetic health of the populations) or to colonize new habitats as habitat quality changes. Thus, both the oak-heath barrens and the surrounding habitat matrix are important to the long-term viability of these species.

We believe the oak-heath barrens in the study area have good habitat quality and high biodiversity potential. We observed five-lined skink in one barren in the Fishkill portion of the study area and found suitable habitat for other rare species in most other barrens we visited. We recommend that these oak-heath barrens be considered potentially important habitats for biodiversity and that the following recommendations be implemented to safeguard their integrity.

Recommendations: Individual oak-heath barrens are not usually threatened by development because the steep rocky terrain makes the construction of houses, roads, and other structures expensive. Barrens occurring along hill summits and ridge tops, however, may be viewed as prime sites for communication (cell) towers. These barrens are also frequented by people seeking the scenic views, and thus are often subjected to ATV and foot traffic. All of these disturbances can severely degrade oak-heath barren habitat and expose the rare reptiles to fatal human encounters. Although the barrens themselves may not be developed, the surrounding habitats frequently are. Such development can destroy vital snake foraging habitat and sever the important travel corridors between interbreeding populations.
To help protect oak-heath barren habitats and their associated rare species, we recommend the following measures within priority zone 5:

1) *Protect oak-heath barren habitats.* All oak-heath barrens and their closely associated crest, ledge, and talus habitats should be protected from disturbances of any kind including, but not limited to, the construction of communication towers, mining, housing and road construction, and high intensity human recreation. We believe the landscapes that encompass oak-heath barrens may be ideal targets for long-term land preservation efforts. Wherever possible, we recommend that special effort be taken to minimize or prevent the adverse

effects associated with human activity in these areas. Posting cautionary signs that warn of the fragile nature of the habitat may be an important first step.

2) *Protect critical adjoining habitats*. As discussed above, the various upland and wetland habitats surrounding oak-heath barrens can provide important summer foraging habitat and travel corridors for rare reptiles. We advise that habitats within at least 3,300 ft (1,000 m) of an oak-heath barren be considered critical components of the barren habitat "complex." New development of any kind should be avoided within this 3,300 ft zone. If development cannot be avoided, it should be concentrated in a manner that maximizes the amount and connectivity of undisturbed habitat. Special measures may also need to be taken (in consultation with the New York State Department of Environmental Conservation) to restrict the potential movement of rare snakes into the newly developed areas, thereby minimizing the likelihood of human-snake encounters (which are often fatal for the snake) and road mortality. Protecting large areas of contiguous habitat surrounding oak-heath barrens will not only protect the potential foraging habitats and travel corridors, it may also help support the ecological and natural disturbance processes (e.g. fire) that help sustain these barrens habitats.

3) *Maintain corridors between oak-heath barren habitat complexes*. Perhaps one of the greatest threats to the long-term viability of the rare animals associated with oak-heath barrens is the fragmentation of habitat complexes from one another. The low-lying valley areas typically found between ridge-top barren complexes are often seen as prime development sites. The construction of houses, roads, and other structures in these areas can isolate habitat complexes and the animal populations they support by preventing dispersal and genetic exchange. This, in turn, can limit the ability of these populations to adapt to changing climatic or environmental conditions and makes them more prone to local extinction. It is important, therefore, that the intervening areas between habitat complexes remain intact to provide important long-distance migration

corridors for these species. We believe special efforts should be taken to identify and protect the potential travel corridors between oak-heath barren complexes within priority Zone 5.

Priority conservation zone 5 (see figures 7 and 8) may be the minimum area needed to protect some of rare reptile species commonly associates with barren habitats. Some species, however, require much larger areas of habitat to meet their foraging needs. We strongly recommend that all activity proposed in the vicinity of an oak-heath barren be thoroughly reviewed in consultation with the Endangered Species Unit of the New York State Department of Environmental Conservation.

- ### *Priority Zone 6: Acidic Bog*

Target Habitats: This zone encompasses a single acidic bog in the Fishkill portion of the study area and the area within 660 ft (200 m) of the bog.

Conservation Issues: Acidic bogs are a rare habitat type in the Hudson Valley and many of the indicator species of bogs are scarce in the region, including pitcher-plant, sundews, and cranberries. Acidic bogs can also support several species of conservation concern including golden-winged warbler, northern waterthrush, four-toed salamander, and pod-grass, among others (see Appendix A).

We consider the one mapped acidic bog to be an ecologically significant habitat due to its rarity, relatively large size, high habitat quality, and potential to support rare species. We recommend, therefore, that the special protective measures discussed below be implemented within priority zone 6 to safeguard the integrity of this sensitive habitat.

Recommendations: Acidic bogs are maintained largely by nutrient poor precipitation. Activities that alter the quality and quantity of water entering the bog have the potential to change the composition of the plant community over the long-term. Sphagnum moss, for example, appears to be particularly sensitive to pollutants such as chloride from road salt and other sources (Wilcox 1986). Acidic bogs are also sensitive to removal of the surrounding forest habitat. The loss of a forested "buffer" can result in warming of the bog mat, increased sediment and pollutant loading, and greater stormwater runoff entering the bog.

To help protect the sensitive acidic bog habitat, we recommend the following protective measures within priority zone 6:

1) *Protect acidic bog habitat.* The acidic bog habitat should be protected from disturbances of any kind including development, dredging, use as a stormwater detention basin, and intense human recreation. We believe the acidic bog and surrounding landscape may be an ideal target for long-term land preservation efforts. If the site is acquired for public access (e.g. as part of a nature preserve), we recommend that special effort be taken to minimize or prevent the adverse effects associated with human activity in this habitat. Boardwalks or viewing platforms should be limited to carefully selected discreet locations at the bog perimeter only, and should be constructed to protect soils, water quality, and vegetation, and to minimize visual or noise disturbance of the bog community. Cautionary signs that warn of the fragile nature of the habitat should also be posted.

2) *Maintain a forested buffer within 660 ft of the bog.* Forest habitats within 660 ft (200 m) of the bog provide an important buffer that helps maintain a cool microclimate in the bog, filter nutrients and other contaminants from runoff, and prevent surface waters from flooding the bog. We recommend that the forested habitats surrounding the bog be protected to the greatest extent possible. The undisturbed habitats surrounding the bog may also be ideal targets for long-term land preservation efforts. Activities such as land clearing and the construction of new houses and roads should be avoided within 660 ft of the bog.

3) *Maintain surface water quality*. Acidic bogs are adversely affected by changes in both the amount and quality of surface water that they receive. Impervious surfaces such as roads and buildings can increase surface water runoff to a bog, thereby altering the hydrology of these habitats. This runoff is often contaminated with nutrients and other pollutants such as road salts, hydrocarbons, minerals, sediment, pesticides, and herbicides. These contaminants can alter the vegetation structure or plant community composition, and can render the habitats unsuitable for the species of conservation concern. Changes to bog water quality and hydrology should be avoided to the greatest extent possible. Some protective measures that would help achieve this are listed below:

- Do not use acidic bogs for stormwater detention, either temporarily or permanently.
- Aggressively treat stormwater in the vicinity of the bog using methods that allow for the maximum infiltration and filtration of runoff, including grassy swales and filter strips.
- Avoid or minimize the use of pesticides, herbicides, and fertilizers within the bog's drainage basin to the greatest extent possible.
- Maintain surface water runoff inputs to acidic bogs at pre-construction levels. Avoid changes (either increases or decreases) in bog hydrology.
- Minimize impervious surfaces including roads, parking lots, and buildings to reduce runoff problems and resulting stormwater management needs.

➢ *Priority Zone 7: Tidal Habitats*

Target Habitats: This zone encompasses all intertidal marsh and mudflat habitats mapped in the Fishkill portion of the study area and a protective zone extending 660 ft (200 m) from these habitats.

Conservation Issues: Intertidal marshes and mudflats are uncommon in the Hudson Valley and many provide important habitat to a number of plant and animal species of conservation concern (see Appendix A). Birds such as least bittern, king rail, northern harrier (all NYS Threatened), American bittern (NYS Special Concern), Virginia rail, sora, common moorhen, and marsh wren (all regionally rare) depend on marshes for nesting and foraging. These birds are often easily disturbed by most types of human activity in or near the marsh, especially during the nesting season.

We observed suitable nesting habitat for marsh breeding birds in all of the intertidal marshes in the study area. We recommend, therefore, that the marshes and mudflats in priority zone 7 be considered potential habitat for marsh breeding birds and that the special protective measures discussed below be implemented to protect these species.

<u>Recommendations:</u> Human activity near a marsh, such as hiking (e.g. on a boardwalk), using motorized watercraft, and ATV riding in the surrounding uplands, can flush marsh birds from their nests and foraging areas. Such disturbances can diminish nesting success by making the eggs and fledglings more susceptible to predation. Chronic disturbance may also discourage these birds from even attempting to nest in the marsh habitat. Physical disturbance to the soils and the plant community may encourage the invasion of plant species such as common reed and purple loosestrife, which can render these habitats unsuitable for many marsh breeding birds and other species of conservation concern.

To protect marsh breeding birds and the habitats they require, we recommend the following protective measures be taken within priority zone 7:

1) *Protect the intertidal marsh/mudflat complex.* The intertidal marshes and mudflats within this priority zone should be protected from disturbances of any kind including dredging, channelization of the tidal tributary mouth and associated tidal channels, removal of vegetation, alteration of tidal hydrology, and intensive human recreational use. We believe this intertidal marsh/mudflat complex may be an ideal target for long-term land preservation efforts. If the

site and bordering uplands are acquired for public access (e.g. as part of a nature preserve), we recommend that special effort be taken to minimize or prevent the adverse effects associated with human recreation in these habitats, including minimizing human activity during the nesting and fledgling season of marsh birds.

2) *Maintain an undisturbed buffer within 660 ft of the marsh/mudflat complex.* Broad areas of undisturbed habitats, especially forests, can help mitigate noise disturbance from nearby land uses by deflecting or muffling the noise before it reaches the marsh. Such a buffer can help minimize disturbance to marsh breeding birds and other wildlife. We recommend that all habitats within 660 ft (200 m) of the marshes and mudflats be protected to the greatest extent possible to serve as a noise and visual buffer. If development within this buffer cannot be avoided, it should be designed to minimize potential adverse impacts to marsh breeding birds. Measures that could help minimize impacts to these species include timing construction activities to coincide with the end of the nesting and fledgling season, using the greatest possible setback distance from the marsh, and minimizing disturbance or clearing of densely vegetated areas between the marsh and the development.

Other activities that could potentially disturb marsh birds should also be avoided within this protective buffer zone, including but not limited to the use of motorized watercraft, intensive human recreation, and ATV riding. If the site is made accessible to the public, any boardwalks or observation decks constructed near the marsh should be located at the most distant and discreet vantage points and trails should not follow the wetland-upland boundary to minimize human contact with marsh birds and other species of conservation concern.

➢ *Priority Zone 8: Large Forests*

Target Habitats: This zone includes certain hardwood, mixed, and conifer forests (both upland and wetland) that we believe may be especially important for maintaining local biodiversity. In general, these forests were greater than 100 ac (40 ha). In a few instances, we also selected smaller forests that could potentially serve as wildlife travel corridors or “stepping stones” between nearby habitats.

In most cases, these forested areas extended beyond the corridor boundary to encompass a much larger area. For example, each of these forests in the Beekman portion of the study area (see figure 9) was approximately 500 ac (200 ha) in total when the unmapped forest outside the corridor was considered. Several of the important forests in the LaGrange portion of the study area (see figure 10) also extended beyond the corridor boundary to encompass a total of 400-600 ac (160-240 ha) or more, including the forested swamp at the southern end of the corridor, the forested hill northeast of Velie Road, and the forest south of Sunset Hill Road. The most extensive forest in the LaGrange study area occurred at the very northern end of the corridor. This forest, which extended into the Town of Pleasant Valley, may encompass a total of several thousand acres. Two important forests in the Fishkill portion of the study area (see figure 11) were also quite extensive. Forest along Honness Mountain just north of Interstate 84 totaled nearly 700 ac (280 ha) when the contiguous forest beyond the corridor was included. The most extensive forest habitat however, occurred on Fishkill Ridge just south of Interstate 84 and encompassed an estimated 8,000 ac (3,240 ha) beyond the study area corridor.

Conservation Issues: Large blocks of unfragmented forest are increasingly uncommon in rapidly developing areas of southern Dutchess County. Large forests provide crucial habitat for numerous “area-sensitive” species that require many hundreds or thousands of acres of contiguous forest to survive and successfully reproduce in the long-term. Large forests, particularly those that are more round and less linear, also support “forest interior” species that are highly sensitive to disturbance and predation along forest edges. Most of these area-sensitive and forest interior species are rare or declining due to the loss of large forest habitats.

Although many of the forests identified as important within the study area may be too small to support the successful reproduction of the most sensitive species (with the exception of the forest along Fishkill Ridge in Fishkill), they may nonetheless be vital for maintaining local biodiversity and supporting other rare or vulnerable species. Some area-sensitive forest birds that appear to be at least moderately successful in forest patches between 100-700 ac (40-280 ha), such as wood thrush, ovenbird, barred owl, and red-shouldered hawk, (all species of conservation concern, see Appendix A), may in fact use the larger forests within priority zone 8. Other species such as the regionally vulnerable bobcat may use the larger forests within the study area for foraging, denning, and travel. We expect that box turtle (NYS Special Concern) may be locally common within many forests in the study area. For these and other reasons, the large forest patches identified within priority zone 8 are potentially significant to biodiversity and should be protected.

<u>Recommendations:</u> Forest habitats are particularly susceptible to loss and disturbance from development and other human activity. Development along the edges of a forest can "chip-away" at the available habitat over time, while development that extends into the forest interior can fragment the habitat into smaller and more isolated patches. This, in turn, can have significant adverse affects on area-sensitive and forest interior species, as well as on local biodiversity and ecosystem dynamics in general.

We recommend that the remaining blocks of large forest within the study area be considered priority areas for conservation, and that efforts be taken to fully protect these habitats wherever possible. If new development cannot be avoided, it should be concentrated near forest edges and near existing development so that as much forest area as possible is preserved. New roads or even driveways should not extend into the interior of the forest and should not divide the habitat into smaller isolated patches.

➢ *Priority Zone 9: Large Meadows and Shrublands*

Target Habitats: This zone includes certain upland meadow, upland shrubland, and wet meadow habitats that we believe may be especially important to local biodiversity. In general, these meadows were greater than 25 ac (10 ha) with the largest occurrences around 100 ac (40 ha). In a few cases we also selected smaller meadows that could potentially serve as wildlife travel corridors or "stepping stones" between nearby habitats.

As with the important forest habitats discussed above, several of these meadows extended beyond the corridor boundary to encompass a much larger area. In the Beekman portion of the study area, a meadow complex just west of Clove Valley Road in the north end of the corridor totaled more than 300 ac (120 ha) when contiguous meadow habitat in the Town of Union Vale was included. In the LaGrange portion of the study area, a meadow that extended beyond the corridor boundary just west of Lauer Road totaled nearly 100 ac (40 ha), while an abandoned hayfield just south of Noxon Road was approximately 200 ac (80 ha) when contiguous meadow to the east was included.

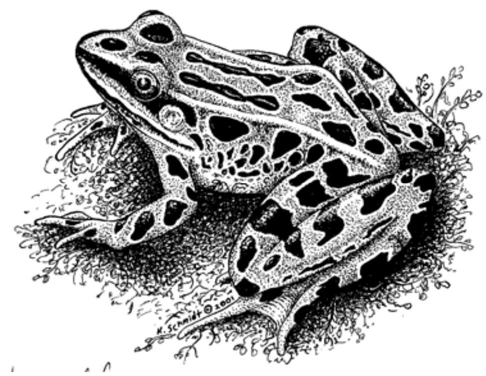
Conservation Issues: Meadows are disappearing from the landscape at a faster rate then most other habitat types. Not only are meadows an important scenic resource in the study area, they are also an important ecological resource. In particular, larger blocks of meadow (especially those unfragmented by hedgerows and fences) are potential breeding habitat for several species of rare or declining grassland birds. Most of these grassland breeding birds require meadow patches many hundreds of acres in size in order to successfully reproduce. The pronounced decline in grassland breeding bird populations in the Northeast has been attributed to the loss of large meadow habitats (Askins 1993, Vickery 1994, Jones and Vickery 1995).

Grassland breeding bird species that have particularly large habitat area requirements may not be successful in the important meadow habitats identified in priority area # 9. Some grassland birds that appear to be at least moderately successful in meadow patches greater than 25 ac (10 ha), such as savannah sparrow, vesper sparrow, bobolink, eastern meadowlark (all species of conservation concern, see Appendix A), may in fact use the larger meadows within priority zone 9. Some of the meadows within the study area may also be prime nesting habitat for Blanding's turtle (NYS Threatened) and wood turtle (NYS Special Concern). We recommend, therefore, that efforts be made to protect the meadows within priority zone # 9.

Recommendations: Meadows are among the habitats most vulnerable to future development. In agricultural areas, for example, development is often an attractive alternative to the economic challenges faced by small farmers. Even when development does not destroy the entire meadow habitat, the remaining fragments are usually small and of much lower biodiversity value. Meadows and the rare species they support are also highly susceptible to other human activities such as mowing, conversion to crop agriculture, pesticides, and ATV traffic. Development around meadows can also promote increased predation on grassland breeding bird nests by human-subsidized predators such as raccoon.

We believe large meadows and meadow complexes should be priority areas for long-term preservation. If development of meadows cannot be avoided, every effort should be made to concentrate any new development in one area near existing roads at meadow edges so that as much meadow habitat as possible remains intact. Wherever possible, new roads and driveways should not divide individual meadows into smaller patches or fragment meadow complexes. If meadows must be mowed, we recommend that it be timed to coincide with the post-fledging season for most birds (e.g. September and later) wherever possible.

CONCLUSION



Northern leopard frog
(K. Schmidt © 2001)

In the suburban and rural landscapes of southern Dutchess County, including in the study area, there are still significant opportunities for biodiversity conservation. Development pressure is on the rise, however, and strategic land use and conservation planning is needed to ensure that species, communities, and ecosystems are protected for the long term. Through our habitat mapping work, Hudsonia hopes to equip town agencies, landowners, and others with information about local habitats of ecological significance so they can take steps to protect the resources of greatest importance to them.

The "habitat approach" to conservation, however, is quite different from the traditional parcel-by-parcel approach to land use decision making. It requires examining the landscape beyond the boundaries of any particular land parcel, and considering the size and juxtaposition of habitats in the landscape, the kinds of biological communities and species they support, and the ecological processes that help to maintain those habitats and species. After conveying the completed habitat map, database, and report to the towns of Beekman, LaGrange, and Fishkill and the City of Beacon, Hudsonia hopes to assist town and city officials, local landowners, and other interested individuals and groups in interpreting the map, understanding what ecological resources exist within the town, and devising ways to integrate this new information into land-use planning and decision making.

We believe that the habitat maps are an invaluable tool for land use and conservation planning. An understanding of the significant ecological resources in the town will enable local decision makers to focus limited conservation resources where they will have the greatest impact. The maps provides a bird's-eye view of the Fishkill Creek and Sprout Creek corridors, illustrating the location and configuration of ecologically significant habitats. At the printed scale of 1:10,000, many important ecological and land-use patterns emerge, such as the location and extent of remaining unfragmented forest blocks, the areas where fens or other rare habitats are concentrated, and the patterns of habitat fragmentation caused by roads and private residential development. This kind of general information can help the three towns think about where future development should be concentrated and where future conservation efforts should be targeted.

At the site-specific scale, we hope the map will be used as a resource during routine deliberations over development proposals and other proposed land use changes within the study area. The map and report bring an independent body of information to site design and environmental reviews, and will help users raise questions about important biological resources that might otherwise be overlooked. We strongly emphasize, however, that the maps have not been exhaustively field-checked and should therefore be used only as a source of general information. In an area proposed for development, for example, the habitat maps and this report can provide basic ecological information about the site and the surrounding lands. The maps, however, should never be considered a substitute for site visits by qualified professionals. During site visits, the presence and boundaries of important habitats can be verified, and the site can be assessed for additional ecological values, such as rare species occurrences. This detailed, up-to-date information is essential to making informed decisions about specific development proposals. Because the natural landscape and patterns of human land use are dynamic, it is important for the towns to consider refining and/or updating the habitat map over time.

Conservation of habitats is one of the best ways to protect biological resources. We hope that the information contained in the habitat maps and in this report will help town decision-makers plan wisely for future development while taking steps to protect biological resources of greatest importance. Incorporating this approach into planning and decision making will help to minimize the adverse effects of human activities, to integrate the needs of the human community with those of the natural landscape, and to protect the ecological patterns and processes that support the human community and the rest of the living world.

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Appendix A. Some species of conservation concern potentially associated with habitats in the towns of Beekman, Fishkill, and LaGrange, and the City of Beacon. These are not comprehensive lists, but are merely a sample of the species of conservation concern known to use these habitats in the region. The two-letter codes given with each species name denote conservation status. Codes include **NYS ranks** (E, T, R, SC), **NY Natural Heritage Program ranks** (S1, S2, S3), and **regional ranks** (RG). For birds, we also indicate those species listed by Partners in Flight as high conservation priorities at the continental (PIF1) and regional (PIF2) level. This ranking system is explained in Appendix B.

UPLAND DECIDUOUS FOREST		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
silvery spleenwort (RG)	Jefferson salamander (SC, S3)	eastern wood-pewee (RG, PIF2)
American ginseng (RG)	blue-spotted salamander (SC, S3)	Acadian flycatcher (S3)
red baneberry (RG)	marbled salamander (SC, S3)	wood thrush (RG, PIF1)
blue cohosh (RG)	northern goshawk (SC, S3N)	cerulean warbler (SC, PIF1)
leatherwood (RG)	red-shouldered hawk (SC)	black-throated blue warbler (RG)
hackberry (RG)	Cooper's hawk (SC)	black-throated green warbler (RG)
sweet-gum (RG)	sharp-shinned hawk (SC)	ovenbird (RG)
Vertebrates	broad-winged hawk (RG)	southern bog lemming (RG)
wood frog (RG)	American woodcock (RG, PIF1)	bobcat (RG)
spotted salamander (RG)	barred owl (RG)	fisher (RG)

UPLAND CONIFER FOREST		
Vertebrates	***Vertebrates (cont.)***	***Vertebrates (cont.)***
blue-spotted salamander (SC, S3)	long-eared owl (S3)	blackburnian warbler (RG, PIF2)
Cooper's hawk (SC)	short-eared owl (E, S2, PIF1)	pine siskin (RG)
sharp-shinned hawk (SC)	barred owl (RG)	red-breasted nuthatch (RG)
American woodcock (RG, PIF1)	black-throated green warbler (RG)	evening grosbeak (RG)

RED CEDAR WOODLAND		
Plants	***Vertebrates***	***Vertebrates (cont).***
large twayblade (E, S1)	eastern hognose snake (SC, S3S4)	northern harrier (T, S3B, S3N)
yellow wildflax (T, S2)	Blanding's turtle (T, S2S3)	northern saw-whet owl (S3)
Carolina whitlow-grass (T, S2)	spotted turtle (SC, S3)	long-eared owl (S3)
Bicknell's sedge (T, S3)	wood turtle (SC, S3)	short-eared owl (E, S2, PIF1)
Invertebrates	eastern box turtle (SC, S3)	
olive hairstreak (butterfly) (RG)	eastern bluebird (RG)	

UPLAND SHRUBLAND		
Plants	***Vertebrates***	***Vertebrates (cont.)***
stiff-leaf goldenrod (T, S2)	wood frog (RG)	golden-winged warbler (SC, PIF1)
small-flowered agrimony (S3)	Blanding's turtle (T, S2S3)	prairie warbler (PIF1)
shrubby St. Johnswort (T, S2)	spotted turtle (SC)	yellow-breasted chat (SC, S3)
devil's-bit (T, S1S2)	eastern box turtle (SC)	clay-colored sparrow (P, S2)
butterfly weed (RG)	wood turtle (RG)	vesper sparrow (SC)
Invertebrates	northern harrier (T, S3B, S3N)	grasshopper sparrow (SC, PIF2)
Aphrodite fritillary (butterfly) (RG)	short-eared owl (E, S2, PIF1)	Henslow's sparrow (T, S3B, PIF1)
dusted skipper (butterfly) (S3)	northern saw-whet owl (S3)	
Leonard's skipper (butterfly) (RG)	loggerhead shrike (E, S1B)	
cobweb skipper (butterfly) (RG)	blue-winged warbler (PIF1)	

UPLAND MEADOW		
Plants	***Vertebrates***	***Vertebrates (cont.)***
Bush's sedge (S3)	Blanding's turtle (T, S2S3)	eastern bluebird (RG)
Invertebrates	spotted turtle (SC, S3)	vesper sparrow (SC)
Aphrodite fritillary (butterfly) (RG)	eastern box turtle (SC, S3)	grasshopper sparrow (SC, PIF2)
dusted skipper (butterfly) (S3)	wood turtle (SC, S3)	Henslow's sparrow (T, S3B, PIF1)
Leonard's skipper (butterfly) (RG)	northern harrier (T, S3B, S3N)	bobolink (RG)
swarthy skipper (butterfly) (RG)	upland sandpiper (T, S3B, PIF1)	eastern meadowlark (RG)
	sedge wren (T, S3B, PIF2)	

OAK-HEATH BARREN and NON-CALCAREOUS CREST, LEDGE, & TALUS

Plants
mountain spleenwort (T, S2S3)
Bicknell's sedge (T, S3)
bronze sedge (RG)
clustered sedge (T, S2S3)
reflexed sedge (E, S2S3)
whorled milkweed (RG)
blunt-leaf milkweed (RG)
eastern prickly-pear (RG)
whorled milkwort (RG)
rock sandwort (RG)
downy arrowwood (RG)
goat's-rue (RG)
slender knotweed (R, S3)
dittany (RG)
Torrey's mountain-mint (E, S1)
allegheny-vine (RG)
bearberry (RG)
three-toothed cinquefoil (RG)
stiff-leaf aster (RG)

Invertebrates
Edward's hairstreak (butterfly) (S3S4)
striped hairstreak (butterfly) (RG)
brown elfin (butterfly) (RG)
olive hairstreak (butterfly) (RG)
northern hairstreak (butterfly) (S1S3)
gray hairstreak (butterfly) (RG)
Horace's duskywing (butterfly) (RG)
swarthy skipper (butterfly) (RG)
Leonard's skipper (butterfly) (RG)
cobweb skipper (butterfly) (RG)
dusted skipper (butterfly) (S3)

Vertebrates
slimy salamander (RG)
marbled salamander (SC, S3)
Fowler's toad (RG)
northern copperhead (S3)
eastern hognose snake (SC, S3S4)
worm snake (SC, S3S4)
timber rattlesnake (T, S3)

Vertebrates (cont.)
eastern box turtle (SC, S3)
five-lined skink (S3)
black rat snake (RG)
turkey vulture (RG)
golden eagle (E, S1N)
whip-poor-will (SC, PIF2)
common raven (RG)
winter wren (RG)
eastern bluebird (RG)
hermit thrush (RG)
blackburnian warbler (RG, PIF2)
cerulean warbler (SC, PIF1)
worm-eating warbler (RG, PIF1)
small-footed bat (SC, S2)
boreal redback vole (RG)
porcupine (RG)
fisher (RG)
bobcat (RG)

CALCAREOUS CREST, LEDGE, & TALUS

Plants
side-oats grama (E, S1)
Torrey's mountain-mint (E, S1)
large twayblade (E, S1)
green milkweed (T, S2)
yellow wild flax (T, S2)
Carolina whitlow-grass (T, S2)
devil's-bit (T, S1S2)
smooth cliffbrake (T, S2)
Bicknell's sedge (T, S3)
small-flowered crowfoot (T, S3)
northern blazing-star (T, S2)

Plants (cont.)
Emmons' sedge (S3)
yellow harlequin (S3)
Dutchman's breeches (RG)
pellitory (RG)
roundleaf dogwood (RG)
hairy rock-cress (RG)
walking fern (RG)
purple cliffbrake (RG)

Invertebrates
olive hairstreak (butterfly) (RG)
dusted skipper (butterfly) (S3)

Invertebrates (cont.)
Leonard's skipper (butterfly) (RG)
swarthy skipper (butterfly) (RG)
anise millipede (RG)

Vertebrates
five-lined skink (S3)
eastern hognose snake (SC, S3S4)
northern black racer (RG)
black rat snake (RG)
northern copperhead (S3)

CLAY BLUFF & RAVINE

Plants
goldenseal (T, S2)
leatherwood (RG)
closed gentian (RG)
stiff gentian (RG)
northern white cedar (RG)

Vertebrates
eastern box turtle (SC, S3)
bald eagle (T, S2S3B, S2N)
osprey (SC, S4B)
Cooper's hawk (SC, S4)
cerulean warbler (SC, S4B)

Vertebrates (cont.)
black-throated blue warbler (RG)
black-throated green warbler (RG)

WASTE GROUND

Plants
hair-rush (RG)
toad rush (RG)
orangeweed (RG)
field dodder (S3)
slender pinweed (T, S2)
rattlebox (E, S1)
blunt mountain-mint (T, S2S3)

Plants (cont.)
slender knotweed (R, S3)
river birch (S3)

Vertebrates
Fowler's toad (RG)
Blanding's turtle (T, S2S3)
wood turtle (SC, S3)
eastern hognose snake (SC, S3S4)

Vertebrates (cont.)
northern copperhead (S3)
American black duck (RG, PIF1)
common raven (RG)
grasshopper sparrow (SC, PIF2)
Henslow's sparrow (T, S3B, PIF1)
bank swallow (RG)

HARDWOOD & SHRUB SWAMP and CONIFER SWAMP

Plants
ostrich fern (RG)
wood horsetail (RG)
swamp cottonwood (T, S2)
southern dodder (E, S1)
dwarf huckleberry (E, S1S2)

Invertebrates
ostrich fern borer (S1?)

Vertebrates (cont.)
blue-spotted salamander (SC, S3)
four-toed salamander (RG)
northern leopard frog (RG)
Blanding's turtle (T, S2S3)
eastern box turtle (SC, S3)
spotted turtle (SC, S3)
wood turtle (SC, S3)
great blue heron (RG)

Vertebrates (cont.)
wood duck (RG, PIF2)
red-shouldered hawk (SC)
American woodcock (RG, PIF1)
barred owl (RG)
white-eyed vireo (RG)
eastern bluebird (RG)
prothonotary warbler (P, S2, PIF1*)
Canada warbler (RG, PIF1)

MARSH		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
winged monkey-flower (R, S3)	spotted turtle (SC, S3)	northern harrier (T, S3B, S3N)
buttonbush dodder (E, S1)	pied-billed grebe (T, S3B, S1N)	king rail (T, S1B, PIF1)
spiny coontail (T, S3)	American bittern (SC, S4)	Virginia rail (RG)
Vertebrates	least bittern (T, S3B, S1N)	sora (RG)
northern leopard frog (RG)	wood duck (RG, PIF2)	common moorhen (RG)
Blanding's turtle (T, S2S3)	American black duck (RG, PIF1)	marsh wren (RG)

WET MEADOW		
Invertebrates	***Invertebrates (cont.)***	***Vertebrates (cont.)***
mulberry wing (butterfly) (RG)	Milbert's tortoiseshell (butterfly) (RG)	Virginia rail (RG)
black dash (butterfly) (RG)	phantom cranefly (RG)	American woodcock (RG, PIF1)
two-spotted skipper (butterfly) (RG)	***Vertebrates***	sedge wren (T, S3B, PIF2)
meadow fritillary (butterfly) (RG)	spotted turtle (SC, S3)	Henslow's sparrow (T, S3B, PIF1)
Baltimore (butterfly) (RG)	ribbon snake (RG)	vesper sparrow (SC)
bronze copper (butterfly) (RG)	American bittern (SC)	grasshopper sparrow (SC, PIF2)
eyed brown (butterfly) (RG)	northern harrier (T, S3B, S3N)	southern bog lemming (RG)

FEN and CALCAREOUS WET MEADOW		
Plants	***Plants (cont.)***	***Invertebrates (cont.)***
wood horsetail (RG)	bog valerian (E, S1S2)	mulberry wing (butterfly) (RG)
slender lady's tresses (RG)	alder-leaf buckthorn (RG)	phantom cranefly (RG)
showy ladyslipper (RG)	***Invertebrates***	***Vertebrates***
rose pogonia (RG)	*Gammarus pseudolimnaeus* (amphipod) (RG)	northern leopard frog (RG)
Schweinitz's sedge (T, S2S3)	forcipate emerald (dragonfly) (S1)	bog turtle (E, S2)
handsome sedge (T, S2S3)	Kennedy's emerald (dragonfly) (SNA)	spotted turtle (SC, S3)
ovate spikerush (E, S1S2)	*Pomatiopsis lapidaria* (snail) (RG)	eastern box turtle (SC)
small-flowered agrimony (S3)	eyed brown (butterfly) (RG)	ribbon snake (RG)
spreading globeflower (R, S3)	two-spotted skipper (butterfly) (RG)	sedge wren (T, S3B, PIF2)
swamp birch (T, S2)	black dash (butterfly) (RG)	
scarlet Indian paintbrush (E, S1)	Dion skipper (butterfly) (S3)	

WET CLAY MEADOW		
Plants	***Plants (cont.)***	***Vertebrates (cont.)***
ragged fringed orchid (RG)	winged monkey-flower (R, S3)	eastern box turtle (SC, S3)
slender lady's-tresses (RG)	small skullcap (S3)	wood turtle (SC, S3)
nodding lady's-tresses (RG)	slender gerardia (RG)	Virginia rail (RG)
small-flowered agrimony (S3)	winged loosestrife (RG)	American woodcock (RG)
downy-ground-cherry (E, S1)	fringed gentian (RG)	sedge wren (T, S3B, PIF2)
Frank's sedge (E, S1)	***Vertebrates***	Henslow's sparrow (T, S3B, PIF1)
Bush's sedge (S3)	spotted salamander (RG)	vesper sparrow (SC)
buttonbush dodder (E, S1)	spotted turtle (SC, S3)	grasshopper sparrow (SC, PIF2)

ACIDIC BOG		
Plants	***Plants (cont.)***	***Vertebrates (cont.)***
pod-grass (R, S3)	small cranberry (RG)	golden-winged warbler (SC, PIF1)
cottongrass (RG)	large cranberry (RG)	Nashville warbler (RG)
pitcher-plant (RG)	bog rosemary (RG)	northern waterthrush (RG)
roundleaf sundew (RG)	***Vertebrates***	southern bog lemming (RG)
dragonmouth orchid (RG)	four-toed salamander (RG)	
Virginia chain fern (RG)	eastern bluebird (RG)	

INTERMITTENT WOODLAND POOL		
Plants	***Vertebrates***	***Vertebrates (cont.)***
featherfoil (T, S2)	four-toed salamander (RG)	spotted turtle (SC, S3)
false hop sedge (R, S2)	Jefferson salamander (SC, S3)	wood turtle (SC, S3)
Invertebrates	marbled salamander (SC, S3)	wood duck (RG, PIF2)
black dash (butterfly) (RG)	blue-spotted salamander (RG, S3)	American black duck (RG, PIF1)
mulberry wing (butterfly) (RG)	wood frog (RG)	northern waterthrush (RG)
springtime physa (snail) (RG)	Blanding's turtle (T, S2S3)	

KETTLE SHRUB POOL		
Plants	***Vertebrates***	***Vertebrates (cont.)***
pale alkali-grass (RG)	blue-spotted salamander (SC, S3)	wood duck (RG, PIF2)
short-awn foxtail (RG)	spotted turtle (SC, S3)	American black duck (RG, PIF1)
spiny coontail (T, S3)	ribbon snake (RG)	
buttonbush dodder (E, S1)	Blanding's turtle (T, S2S3)	

OPEN WATER and CONSTRUCTED POND		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
spiny coontail (T, S3)	wood turtle (SC, S3)	osprey (SC)
Vertebrates	spotted turtle (SC, S3)	bald eagle (T, S2S3B)
northern cricket frog (E, S1)	American bittern (SC)	
Blanding's turtle (T, S2S3)	great blue heron (RG)	

SPRINGS and SEEPS		
Invertebrates	***Vertebrates***	
Piedmont groundwater amphipod (RG)	northern dusky salamander (RG)	
gray petaltail (dragonfly) (SC, S2)	spring salamander (RG)	
tiger spiketail (dragonfly) (S1)		

PERENNIAL & INTERMITTENT STREAM		
Plants	***Invertebrates (cont.)***	***Vertebrates (cont.)***
winged monkey-flower (R, S3)	*Pisidium adamsi* (fingernail clam) (RG)	slimy sculpin (fish) (RG)
riverweed (T, S2)	brook floater (mussel) (T, S1)	wood turtle (SC, S3)
spiny coontail (T, S3)	***Vertebrates***	northern dusky salamander (RG)
goldenseal (T, S2)	tadpole madtom (fish) (S3)	spring salamander (RG)
Invertebrates	creek chubsucker (fish) (RG)	wood duck (RG, PIF2)
sable clubtail (dragonfly) (S1)	longnose sucker (fish) (S3)	American black duck (RG, PIF1)
arrowhead spiketail (dragonfly) (S2S3)	bridle shiner (fish) (RG)	bank swallow (RG)
mocha emerald (dragonfly) (S2S3)	brook trout (fish) (RG)	great blue heron (RG)
Marstonia decepta (snail) (RG)	mud sunfish (fish) (T, SH)	

RIPARIAN CORRIDOR		
Plants	***Plants (cont.)***	***Vertebrates***
ostrich fern (RG)	goldenseal (T, S2)	wood turtle (SC, S3)
cattail sedge (T, S2)	false-mermaid (RG)	wood duck (RG, PIF2)
Davis' sedge (T, S2)	swamp rose-mallow (RG)	red-shouldered hawk (SC)
winged monkey-flower (R, S3)	***Invertebrates***	American woodcock (RG, PIF1)
river birch (S3)	ostrich fern borer (S1?)	cerulean warbler (SC, PIF1)
small-flowered agrimony (S3)		river otter (RG)

ESTUARINE ROCKY SHORE		
Plants	***Plants (cont.)***	***Vertebrates***
river quillwort (E, S1)	eastern prickly-pear (RG)	map turtle (RG)
estuary beggarticks (R, S3)	***Invertebrates***	American black duck (PIF1)
heartleaf plantain (T, S3)	falcate orange tip (S3S4)	harbor seal (S3)
terrestrial starwort (T, S2S3)	hackberry butterfly (S3S4)	
northern white cedar (RG)		

SUPRATIDAL RAILROAD CAUSEWAY		
Plants	***Plants (cont.)***	***Vertebrates***
Canada lily (RG)	kidneyleaf mud-plantain (T, S3)	spotted turtle (SC, S3)
Frank's sedge (E, S1)	Drummond's rock-cress (E, S2)	wood turtle (SC, S3)
Davis' sedge (T, S2)	green-headed coneflower (RG)	diamondback terrapin (S3)
hair-rush (RG)	slender knotweed (R, S3)	map turtle (RG)
swamp lousewort (T, S2)		

TIDAL TRIBUTARY MOUTH

Plants
river quillwort (E, S1)
goldenclub (T, S2)
estuary beggar ticks (R, S3)
smooth bur-marigold (T, S2)
winged monkey-flower (R, S3)
lizard's tail (RG)

Invertebrates
Pteronarcys (stonefly) (RG)
Pomatiopsis lapidaria (snail) (RG)

Vertebrates
American brook lamprey (S3)
northern hog sucker (RG)
rainbow smelt (RG)

Vertebrates (cont.)
American bittern (SC, S4)
bald eagle (T, S2S3B, S2N)
osprey (SC, S4B)

INTERTIDAL MARSH

Plants
smooth bur-marigold (T, S2)
heartleaf plantain (T, S3)
estuary beggar ticks (R, S3)
American waterwort (E, S1)
winged monkey-flower (R, S3)
swamp rose-mallow (RG)
closed gentian (RG)

Invertebrates
coastal broad-winged skipper (RG)

Vertebrates
least bittern (T, S3B, S1N)
American bittern (SC, S4)
osprey (SC, S4B)
northern harrier (T, S3B, S3N)
bald eagle (T, S2S3B, S2N)

Vertebrates (cont.)
king rail (T, S1B, PIF1)
black rail (E, S1B)
Virginia rail (RG)
sora (RG)
common moorhen (RG)
marsh wren (RG)
blue-winged teal (RG)

INTERTIDAL MUDFLAT

Plants
river quillwort (E, S1)
heartleaf plantain (T, S3)
kidneyleaf mud-plantain (S3)
Hudson River water-nymph (E, S1)

Invertebrates
alewife floater (mussel) (S1S2)
yellow lampmussel (mussel) (S3)
tidewater mucket (mussel) (S1)

Vertebrates
shortnose sturgeon (E, S1)
American brook lamprey (S3)
northern hog sucker (RG)
diamondback terrapin (S3)
map turtle (RG)
least bittern (T, S3B, S1N)
American bittern (SC, S4)

Vertebrates (cont.)
ruddy duck (S1)
redhead (RG)
oldsquaw (RG)
red-breasted merganser (RG)
osprey (SC, S4B)
bald eagle (T, S2S3B, S2N)

INTERTIDAL SWAMP

Plants
goldenclub (T,S2)
small purple fringed orchid (RG)

Plants (cont.)
Sprengel's sedge (RG)
winged monkey-flower (R, S3)
green dragon (RG)
vetchling (RG)
swamp lousewort (T, S2)
spring cress (RG)

Invertebrates
coastal broad-winged skipper (RG)

Vertebrates
northern leopard frog (RG)
wood turtle (SC, S3)

Vertebrates (cont.)
bald eagle (T, S2S3B, S2N)
osprey (SC, S4B)
barred owl (RG)
red-headed woodpecker (SC,S4)
white-eyed vireo (RG)

Appendix B. Explanation of ranks of species of conservation concern listed in Appendix A. Explanations of New York State ranks and New York Natural Heritage Program ranks are from the New York Natural Heritage Program website, updated May 2003.

New York State Ranks

The following categories are defined in regulation 6NYCRR part 193.3 and apply to New York State Environmental Conservation Law section 9-1503.

E **Endangered Species**. Any species which meets one of the following criteria: species with 5 or fewer extant sites or fewer than 1,000 individuals; species restricted to fewer than 4 USGS 7 ½ minute topographical maps; or species listed as endangered by the U.S. Department of the Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.

T **Threatened Species**. Any species which meets one of the following criteria: species with 6 to 20 extant sites or 1,000-3,000 individuals; species restricted to not less than 4 or more than 7 USGS 7 ½ minute topographical maps; or species listed as Threatened by the United States Department of the Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.

R **Rare Species (plants only)**. Species with 20-35 extant sites or 3,000-5,000 individuals statewide.

SC **Special Concern Species**. Those species which are not yet recognized as endangered or threatened, but for which documented concern exists for their continued welfare in New York. Unlike the first two categories, species of special concern receive no additional legal protection under Environmental Conservation Law section 9-1503.

P **Protected Wildlife**. Wild game, protected wild birds, and endangered species of wildlife, defined in Environmental Conservation Law section 11-0535.

New York Natural Heritage Program Ranks (Statewide)

S1 Critically imperiled in NY State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from NY State due to biological factors.

S2 Imperiled in NY State because of rarity (6-20 sites or few remaining individuals) or highly vulnerable to extirpation in NY State due to biological factors.

S3 Rare in NY State (usually 21-100 extant sites).

SH Historical. No extant sites known in New York State but it may be rediscovered.

B, N These modifiers indicate when the breeding status of a migratory species is considered separately from individuals passing through or not breeding within New York State. B indicates the breeding status, N indicates the non-breeding status.

? Indicates that a question exists about the species' rank.

Regional Status (Hudson Valley)

RG Hudsonia has compiled lists of native plants and animals that are rare in the Hudson Valley but do not appear on statewide or federal lists of rarities (Kiviat and Stevens 2001). We use ranking criteria similar to those used by the NYNHP, but we apply those criteria to the Hudson Valley below the Troy Dam. Our regional lists are based on the extensive field experience of biologists associated with Hudsonia and communications with other biologists working in the Hudson Valley. These lists are subject to change as we gather more information about species occurrences in the region. In this report, we denote all regional ranks (rare, scarce, declining, vulnerable) with a single code (RG). Species with New York State or New York Natural Heritage Program ranks are presumed to be regionally rare also, but are not assigned an 'RG' rank.

Partners in Flight Priority Species Lists

Based on August 2003 lists for physiographic areas # 17 (Northern Ridge and Valley) and # 9 (Southern New England).

PIF1 High continental priority (Tier IA and IB species)
PIF2 High regional priority (Tier IIA, IIB, and IIC species)
PIF1* Two species were not included in the watch lists for this region; however, they are listed as "High Continental Priority" in PIF's national North American Landbird Conservation Plan (Rich et al. 2004).

Appendix C. Common and scientific names of plants mentioned in this report. Scientific names follow the nomenclature of Mitchell and Tucker (1997).

Common Name	Scientific Name	Common Name	Scientific Name
agrimony, small flowered	*Agrimonia parviflora*	clover, white sweet-	*Melilotus alba*
alder, speckled	*Alnus incana* spp. *rugosa*	cohosh, blue	*Caulophyllum thalictroides*
Allegheny-vine	*Adlumia fungosa*	columbine, wild	*Aquilegia canadensis*
arrow-arum	*Peltandra virginica*	coneflower, green-headed	*Rudbeckia laciniata*
arrowhead	*Sagittaria*	coontail	*Ceratophyllum*
arrowhead, broadleaf	*Sagittaria latifolia*	coontail, spiny	*Ceratophyllum echinatum*
arrowhead, strapleaf	*Sagittaria subulata*	cottonwood, eastern	*Populus deltoides*
arrowwood, downy	*Viburnum rafinesquianum*	cottonwood, swamp	*Populus heterophylla*
arrowwood, northern	*Viburnum dentatum* v. *lucidum*	cranberry, large	*Vaccinium macrocarpon*
ash, green	*Fraxinus pensylvanica*	cranberry, small	*Vaccinium oxycoccos*
ash, white	*Fraxinus americana*	cress, spring	*Cardamine bulbosa*
aster	*Aster*	crowfoot, small-flowered	*Ranunculus micranthus*
aster, purple stem	*Aster puniceus*	crowfoot, yellow water	*Ranunculus flabellaris*
aster, stiff-leaved	*Aster linariifolius*	cut-grass, rice	*Leersia oryzoides*
aster, white wood	*Aster divaricatus*	devil's-bit	*Chamaelirium luteum*
azalea, swamp	*Rhododendron viscosum*	dittany	*Cunila origanoides*
baneberry, red	*Actaea spicata* ssp. *rubra*	dodder, buttonbush	*Cuscuta cephalanthi*
barberry, Japanese	*Berberis vulgaris*	dodder, field	*Cuscuta pentagona*
bearberry	*Arctostaphylos uva-ursi*	dodder, southern	*Cuscuta obtusiflora* v. *glandulosa*
beech, American	*Fagus grandifolia*	dogwood, flowering	*Cornus florida*
beggar-ticks	*Bidens*	dogwood, gray	*Cornus foemina* ssp. *racemosa*
begger-ticks, estuary	*Bidens bidentoides*		
birch, black	*Betula lenta*	dogwood, silky	*Cornus amomum*
birch, gray	*Betula populifolia*	dragon, green	*Arisaema dracontium*
birch, river	*Betula nigra*	duckweed	*Lemna*
birch, swamp	*Betula pumila*	elm	*Ulmus*
bittersweet, Oriental	*Celastrus orbiculata*	elm, American	*Ulmus americana*
blazing-star, northern	*Liatris scariosa* v. *novae-angliae*	false-mermaid	*Floerkea proserpinacoides*
blueberry, highbush	*Vaccinium corymbosum*	featherfoil	*Hottonia inflata*
blueberry, lowbush	*Vaccinium angustifolium*	fern, Christmas	*Polystichum acrostichoides*
blueberry, pale	*Vaccinium pallidum*	fern, cinnamon	*Osmunda cinnamomea*
buckthorn, alder-leaf	*Rhamnus alnifolia*	fern, marsh	*Thelypteris palustris*
buckthorn, common	*Rhamnus cathartica*	fern, ostrich	*Matteuccia struthiopteris*
bulrush	*Scirpus*	fern, royal	*Osmunda regalis*
bulrush, drooping	*Scirpus pendulus*	fern, sensitive	*Onoclea sensibilis*
bur-marigold, smooth	*Bidens laevis*	fern, Virginia chain	*Woodwardia virginica*
bur-reed	*Sparganium*	fern, walking	*Asplenium rhizophyllum*
butterflyweed	*Asclepias tuberosa*	flag, blue	*Iris versicolor*
buttonbush	*Cephalanthus occidentalis*	forget-me-not, small	*Myosotis laxa*
canary-grass, reed	*Phalaris arundinacea*	gentian, closed	*Gentiana andrewsii*
cattail	*Typha*	gentian, fringed	*Gentianopsis crinita*
cattail, narrow-leaf	*Typha angustifolia*	gentian, stiff	*Gentiana quinquefolia*
cedar, eastern red	*Juniperus virginiana*	gerardia, slender	*Agalinis tenuifolia*
cedar, northern white	*Thuja occidentalis*	ginseng, American	*Panax quinquefolius*
cherry, black	*Prunus serotina*	globeflower, spreading	*Trollius laxus*
chickweed, field	*Cerastium arvense*	goat's-rue	*Tephrosia virginiana*
cinquefoil	*Potentilla*	goldenclub	*Orontium aquaticum*
cinquefoil, dwarf	*Potentilla canadensis*	goldenrod, bog	*Solidago uliginosa*
cinquefoil, shrubby	*Potentilla fruticosa*	goldenrod, Canada	*Solidago canadensis*
cinquefoil, three-toothed	*Potentilla tridentata*	goldenrod, downy	*Solidago puberula*
clearweed	*Pilea pumila*	goldenrod, gray	*Solidago nemoralis*
cliffbrake, purple	*Pellaea atropurpurea*	goldenrod, lance-leaved	*Euthamia graminifolia*
cliffbrake, smooth	*Pellaea glabella*	goldenrod, late	*Solidago gigantea*

Common Name	Scientific Name	Common Name	Scientific Name
goldenrod, spreading	*Solidago patula*	(moss)	*Helodium paludosum*
goldenrod, stiff-leaf	*Solidago rigida*	moss, peat	*Sphagnum*
goldenrod, tall hairy	*Solidago rugosa*	mountain-mint	*Pycnanthemum*
goldenseal	*Hydrastis canadensis*	mountain-mint, blunt	*Pycnanthemum muticum*
gooseberry, northern	*Ribes hirtellum*	mountain-mint, Torrey's	*Pycnanthemum torrei*
grama, side-oats	*Bouteloua curtipendula*	mud-plantain, kidneyleaf	*Heteranthera reniformis*
grass-of-Parnassus	*Parnassia glauca*	mustard, garlic	*Alliaria petiolata*
grass, blue-joint	*Calamagrostis canadensis*	nettle, false	*Boehmeria cylindrica*
grass, Indian	*Sorghastrum nutans*	oak, black	*Quercus velutina*
grass, little-bluestem	*Schizachyrium scoparium*	oak, chestnut	*Quercus montana*
grass, pale alkali-	*Torreyochloa pallida* v. *pallida*	oak, pin	*Quercus palustris*
grass, panic	*Panicum*	oak, red	*Quercus rubra*
grass, poverty	*Danthonia spicata*	oak, scarlet	*Quercus coccinea*
ground-cherry, downy	*Physalis pubescens* v. *integrifolia*	oak, scrub	*Quercus ilicifolia*
hackberry	*Celtis occidentalis*	oak, swamp white	*Quercus bicolor*
hairgrass	*Deschampsia flexuosa*	oak, white	*Quercus alba*
hair-rush	*Bulbostylis capillaris*	olive, autumn	*Elaeagnus umbellata*
harlequin, yellow	*Corydalis flavula*	orangeweed	*Hypericum gentianoides*
hellebore, false	*Veratrum viride*	orchid, ragged fringed	*Platanthera lacera*
hemlock, eastern	*Tsuga canadensis*	orchid, small purple fringed	*Platanthera psycodes*
herb-Robert	*Geranium robertianum*	paintbrush, scarlet Indian	*Castilleja coccinea*
hickory	*Carya*	pickerelweed	*Pontederia cordata*
hickory, mockernut	*Carya tomentosa*	pine, pitch	*Pinus rigida*
hickory, pignut	*Carya glabra*	pine, red	*Pinus resinosa*
hickory, shagbark	*Carya ovata*	pine, white	*Pinus strobus*
honeysuckle, Bell's	*Lonicera* x *bella*	pinweed, slender	*Lechea tenuifolia*
horsetail, field	*Equisetum arvense*	pitcher-plant	*Sarracenia purpurea*
hog-peanut	*Amphicarpaea bracteata*	plantain, heartleaf	*Plantago cordata*
huckleberry, black	*Gaylussacia baccata*	pod-grass	*Scheuchzeria palustris*
huckleberry, dwarf	*Gaylussacia dumosa*	poison-ivy	*Toxicodendron radicans*
joe-pye-weed, spotted	*Eupatorium maculatum*	pondweed	*Potamogeton crispus*
knapweed, spotted	*Centaurea maculosa*	prickly-pear, eastern	*Opuntia humifusa*
knotweed, Japanese	*Polygonum cuspidatum*	pussytoes, field	*Antennaria neglecta*
knotweed, slender	*Polygonum tenue*	quillwort, river	*Isoetes riparia*
ladyslipper, pink	*Cypripedium acaule*	ragwort, golden	*Senecio aureus*
lady's-tresses, nodding	*Spiranthes cernua*	rattlebox	*Crotalaria sagittalis*
lady's-tresses, slender	*Spiranthes lacera*	red cedar, eastern	*Juniperus virginiana*
laurel, mountain	*Kalmia latifolia*	reed, common	*Phragmites australis*
leatherleaf	*Chamaedaphne calyculata*	riverweed	*Podostemum ceratophyllum*
leatherwood	*Dirca palustris*	rock-cress, Drummond's	*Arabis drummondii*
lily, Canada	*Lilium canadense*	rock-cress, hairy	*Arabis hirsuta* v. *pycnocarpa*
liverwort	*Riccia fluitans*	rose-mallow, swamp	*Hibiscus moscheutos*
lizard's-tail	*Saururus cernuus*	rose, multiflora	*Rosa multiflora*
lobelia, spiked	*Lobelia spicata*	rose, swamp	*Rosa palustris*
locust, black	*Robinia pseudo-acacia*	rush, Dudley's	*Juncus dudleyi*
loosestrife, purple	*Lythrum salicaria*	rush, soft	*Juncus effusus*
loosestrife, winged	*Lythrum alatum*	rush, toad	*Juncus bufonius*
lousewort, swamp	*Pedicularis lanceolata*	sandwort, rock	*Minuartia michauxii*
maple, red	*Acer rubrum*	sedge	*Carex*
maple, silver	*Acer saccharinum*	sedge, Bicknell's	*Carex bicknellii*
maple, sugar	*Acer saccharum*	sedge, bristly-stalked	*Carex leptalea*
meadow-rue, tall	*Thalictrum pubescens*	sedge, bronze	*Carex aenea*
milkweed, blunt-leaf	*Asclepias amplexicaulis*	sedge, Bush's	*Carex bushii*
milkweed, green	*Asclepias viridiflora*	sedge, cattail	*Carex typhina*
milkweed, whorled	*Asclepias verticillata*	sedge, clustered	*Carex cumulata*
milkwort, whorled	*Polygala verticillata*	sedge, Davis'	*Carex davisii*
mint	*Mentha*	sedge, Emmons'	*Carex albicans* v. *emmonsii*
monkey-flower, winged	*Mimulus alatus*	sedge, false hop	*Carex lupuliformis*

Common Name	Scientific Name	Common Name	Scientific Name
sedge, fescue	*Carex festucacea*	whitlow-grass, Carolina	*Draba reptans*
sedge, fox	*Carex vulpinoidea*	wildflax, yellow	*Linum sulcatum*
sedge, Frank's	*Carex frankii*	willow	*Salix*
sedge, handsome	*Carex formosa*	willow, autumn	*Salix serissima*
sedge, hop	*Carex lupulina*	willow, beaked	*Salix bebbiana*
sedge, interior	*Carex interior*	willow, pussy	*Salix discolor*
sedge, lakeside	*Carex lacustris*	willow, silky	*Salix sericea*
sedge, meadow	*Carex granularis*	winterberry	*Ilex verticillata*
sedge, Pennsylvania	*Carex pensylvanica*	witch-hazel	*Hamamelis virginiana*
sedge, porcupine	*Carex hystericina*		
sedge, prairie	*Carex prairea*		
sedge, reflexed	*Carex retroflexa*		
sedge, Schweinitz's	*Carex schweinitzii*		
sedge, Sprengel's	*Carex sprengelii*		
sedge, sterile	*Carex sterilis*		
sedge, tussock	*Carex stricta*		
Sedge, white tinge	*Carex albicans* v. *albicans*		
sedge, woolly-fruit	*Carex lasiocarpa*		
sedge, yellow	*Carex flava*		
selfheal	*Prunella vulgaris*		
shadbush	*Amelanchier*		
sheep-laurel	*Kalmia angustifolia*		
silver-rod	*Solidago bicolor*		
skullcap, small	*Scutellaria parvula* v. *parvula*		
skunk-cabbage	*Symplocarpus foetidus*		
spatterdock	*Nuphar advena*		
spicebush	*Lindera benzoin*		
spikemoss, rock	*Selaginella rupestris*		
spikerush, olivaceous	*Eleocharis flavescens*		
spikerush, ovate	*Eleocharis obtusa* v. *ovata*		
spleenwort, ebony	*Asplenium platyneuron*		
spleenwort, maidenhair	*Asplenium trichomanes*		
spleenwort, mountain	*Asplenium montanum*		
spleenwort, silvery	*Deparia acrostichoides*		
spruce	*Picea*		
St. Johnswort, shrubby	*Hypericum prolificum*		
starwort, terrestrial	*Callitriche terrestris*		
sumac, poison	*Toxicodendron vernix*		
sundew, roundleaf	*Drosera rotundifolia*		
sweetflag	*Acorus*		
sweet-gum	*Liquidambar styraciflua*		
sycamore	*Platanus occidentalis*		
tearthumb, arrow-leaf	*Polygonum sagittatum*		
touch-me-not, spotted	*Impatiens capensis*		
tree-of-heaven	*Ailanthus altissima*		
tree, tulip	*Liriodendron tulipifera*		
tripe, rock (lichen)	*Umbilicaria*		
twayblade, large	*Liparis lilifolia*		
valerian, bog	*Valeriana uliginosa*		
vetchling	*Lathyrus palustris*		
viburnum, maple-leaf	*Viburnum acerifolium*		
violet	*Viola*		
wall-rue	*Asplenium ruta-muraria*		
water-chestnut	*Trapa natans*		
watermilfoil, Eurasian	*Myriophyllum spicatum*		
water-nymph, Hudson River	*Najas guadalupensis* v. *muenscheri*		
waterwort, American	*Elatine americana*		
water-willow	*Decodon verticillata*		